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Dewey Square
Comprehensive Transportation Systems Management Program

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Draft Environmental Assessment

Transportation Analysis

July, 1984

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84

se / Hangen Associates, Inc.
ortation Engineers & Planners
h Street, Boston, Massachusetts 02110

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CONCLUSIONS - SUMMARY OF FINDINGS 132

- Use of the area's surface street system as a bypass route for traffic attempting to avoid congestion on the Central Artery.

- Heavy bus and truck volumes that are forced to compete with both local and regional traffic on area streets.

- Very heavy pedestrian volumes and a general public disregard of designated crosswalks and signal phases.
- A complicated and awkward system of crosswalks between the retail district and South Station
- A prohibition against trucks carrying dangerous cargos throughout the Central Artery's Dewey Square Tunnel requires they be accommodated on several local streets.
- A need to relate circulation plans to proposed and potential new development.

The problems listed above result in a very inefficient roadway system which is particularly apparent during the peak commuter periods.

where are these?

FUTURE IMPROVEMENTS

This study identified two improvement options to meet the goals of the Study. Alternative A provides for an improved roadway configuration which generally includes the following:

Alternative A

now is, was partly in study area

already are

- Designation of Atlantic Avenue and Lincoln Streets as one-way northbound while South Street and Purchase Street would become one-way southbound. All southbound traffic would be eliminated on Atlantic Avenue and all northbound traffic on Surface Artery would similarly be eliminated. High Street would remain one-way northbound as it is today.

the area under the prefered alternative, outbound buses would utilize Kingston Street, a new exclusive busway in the vicinity of the China Gate at Beach Street and a portion of the Surface Artery to reach the Massachusetts Turnpike. This route would allow buses to bypass most of the Surface Artery and avoid considerable traffic congestion.

- Under Alternative A, several street links would be closed or eliminated to reduce conflicts and resultant congestion. Specifically, South Street northbound would be closed between Essex Street and Summer Street, as would Summer Street eastbound between Purchase Street and High Street. With Alternative A, High Street would remain one-way southbound and the southbound link between High Street and Surface Artery adjacent to the South Station Cinema would remain. Other proposed closings include Bedford Street between Lincoln and Columbia Streets and the closing of Beach, Edinboro and Kingston Streets to through traffic in Chinatown.

Where's
?
AP??

- Both alternatives were developed to accommodate a future southbound on-ramp to the Central Artery at the location of the now closed Lincoln Street northbound exit.

Alternative B

This concept primarily differs in that High Street would be reversed to run in a one-way northbound direction. This change further simplifies operations along Surface Artery, Summer Street

- The critical movement analysis revealed that by 1987, if no improvements are made, intersection LOS will be "D" or below at nine locations (three during the AM and six during the PM). The implementation of Alternative A will also result in nine locations at LOS "D" or below while Alternative B would have 11 12 intersections at LOS "D" or below while Alternative B would have 11 intersection at LOS "D" or below. Intersectons expected to fall into this category include Kneeland Street/Surface Artery, Summer Street/Atlantic Avenue, Purchase Street/Congress Street and Congress Street/Atlantic Avenue.

- The signal analysis revealed several major benefits with the implementation of either alternative. In particular, the following would be accomplished under either alternative:
  - Improved signal coordination and progression between intersections will be possible by reducing conflicts and creating more one-way streets;
  - The elimination of several short roadway links and signals improving progression and reducing conflicts;
  - Pedestrian crossings would also be improved by eliminating conflicts, allowing pedestrians to cross only one traffic movement.
  - Bus prioritization improvements would be gained through the simplified signalization system. Signal coordination would require fewer stops and delays.

This relocation will move the off-ramp to Purchase Street and will be particularly compatible with Alternative B which reverses High Street.

CONCLUSIONS

The implementation of either alternative will greatly enhance the Dewey Square area by improving bus and automobile flow and creating a safer pedestrian environment. In particular, implementation of Alternative B will provide a solution that meets the goals of the study and will be compatible with future long-range plans for depression of the Central Artery.

(Some statement on general environmental and land use benefits would be useful here)

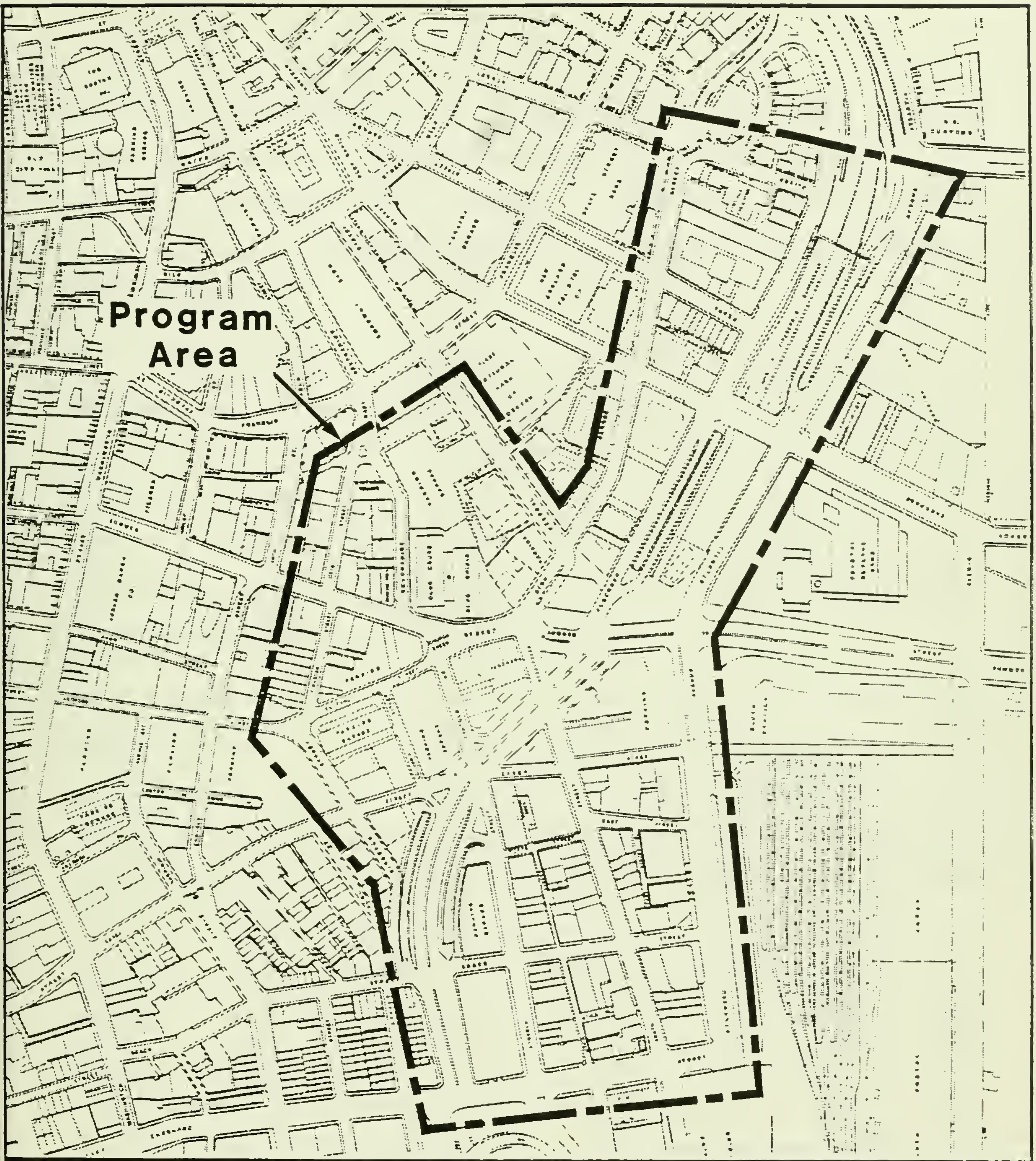

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Figure 1
**Project
Program
Area**

0 200 400
Scale in Feet

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New York City and Washington, D.C. is available on AMTRAK trains which are part of the improved rail service on the Northeast Corridor Improvement Project (NECIP). Commuter rail service is also available via the MBTA/Boston & Maine lines to points west and south of Boston.

The MBTA Red Line currently provides Rapid Transit service between Braintree and Harvard Square, Cambridge with an extension to the Alewife area in Cambridge now under construction. Service is provided on the Red Line to Braintree, Quincy, Dorchester, South Boston, Downtown Boston and Cambridge. Because of the design of the MBTA's system, transfers between the other three rapid transit lines (Blue, Green, Orange) are available.

Both intercity and commuter bus service is available in the Dewey Square area. The temporary Continental Trailways Bus Terminal is located on the west side of Atlantic Avenue above the Dewey Square Tunnel and opposite the Federal Reserve Bank. This terminal accommodates a number of intercity carriers (Continental Trailways, Peter Pan, etc.) while daily commuter buses (Plymouth & Brockton, Brush Hill) generally use the designated area on the east side of Atlantic Avenue south of Summer Street for loading/ unloading operations. The MBTA also runs express commuter buses from the western suburbs which must pass through the area on their designated routes which terminate at the First National and Shawmut Bank Buildings on Federal and Franklin Streets, respectively.

B. LOCAL STREET SYSTEM

Within the study area there are a number of major arterial streets which function as important links in the roadway network. The Surface Artery is a two-way roadway that was constructed above the depressed tunnel section of the Central Artery. It functions as the main spine roadway through the area and provides access to the Massachusetts Turnpike/Southeast Expressway interchange and to the Central Artery. Three other essentially parallel roadways also function as major arterials including Atlantic Avenue, South Street and Lincoln Street. ~~Both~~ South and Lincoln Streets and Atlantic Avenue currently operate as one-way northbound roadways ~~while Atlantic Avenue carries two directions of traffic~~.

Kneeland Street, Summer Street, Congress Street and Northern Avenue function as the major east-west arterials while Beach and Essex Streets which also run east-west are more minor in nature. Table 1 was developed to present a detailed summary of existing surface street characteristics including average width, number of moving traffic lanes, type of operation, parking and the relative importance of each roadway to the local street network. Figure 2 indicates the existing roadway circulation pattern in the program area.

nor

C. TRAFFIC OPERATIONS

In the designated program area, a total of 22 locations are signalized. Of these, four function as pedestrian crossings only while the remaining 18 signals are located at major intersections

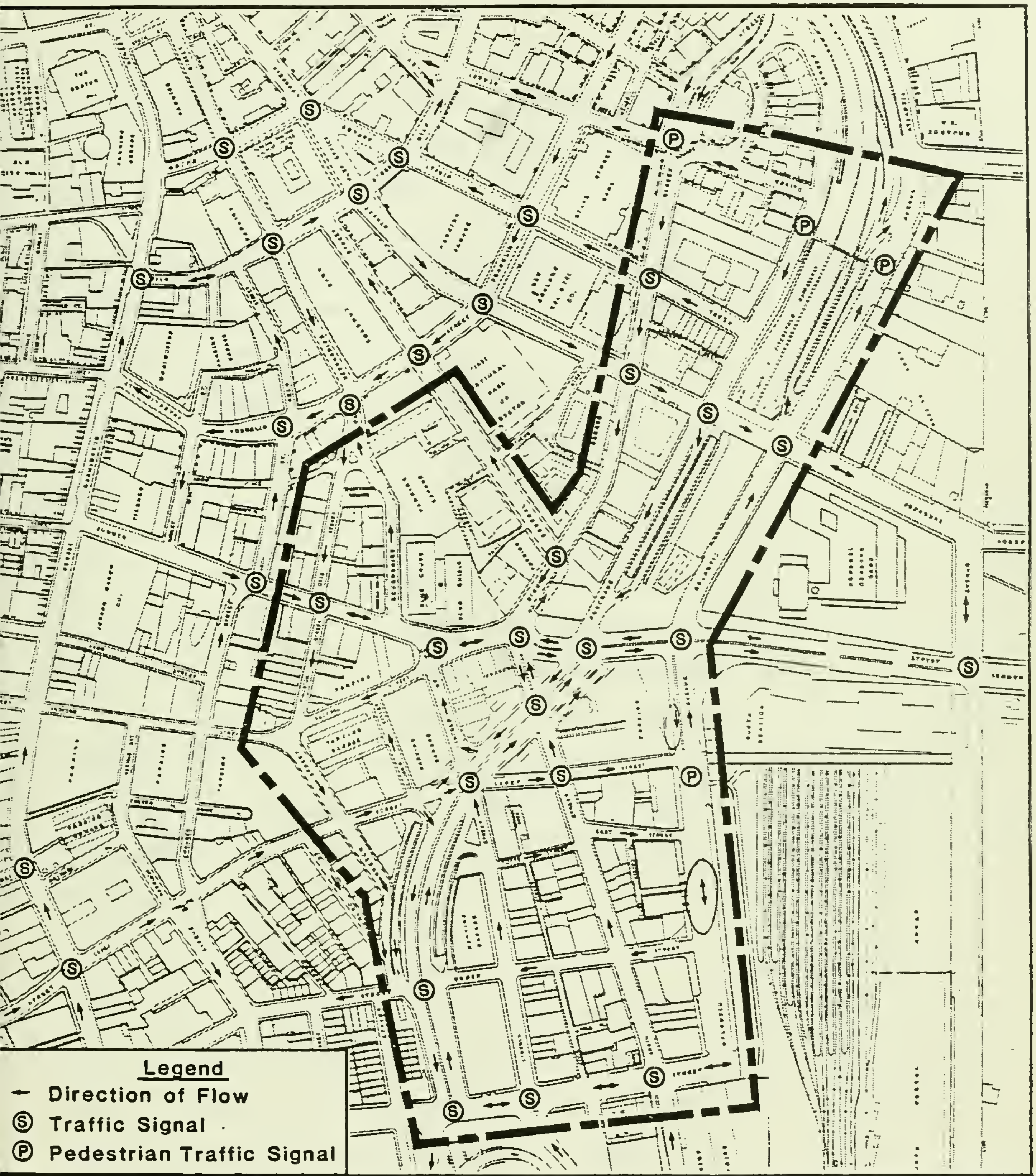

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Figure 2

Program Area Roadway Circulation System

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Scale in Feet

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controlling conflicting traffic streams and pedestrian crossings. Figure 2 presented previously indicated the location of the traffic signals in the program area.

when?

A recent roadway project in Dewey Square included seven intersections that were reconstructed. That project involved the following intersections:

Location	Intersection
I	High Street/South Street
II	Purchase Street/Ramp "RR"
III	Summer Street/Surface Artery
IV	Summer Street/Atlantic Avenue
V	South Street/Surface Artery
VI	Summer Street/Dorchester Avenue
VII	Federal Street/High Street

The seven signals are interconnected and timed to provide coordination between intersections. Two other systems serve portions of the program area. They are the Financial District System and the Surface Artery System.

Traffic flow in and around Dewey Square is controlled by the signalized intersections within the program area. A number of traffic flow problems are regularly experienced in the area as a result of many different factors. Major reasons for peak hour traffic congestion include the following:

D. PEDESTRIAN CONDITIONS

Pedestrian demands are high throughout the Program Area, particularly in the vicinity of the Summer Street corrior. The largest single generator of pedestrian traffic is South Station with its Red Line Stop, commuter rail and bus activity. During peak pedestrian flows, traffic at the main Dewey Square intersection (Summer Street/ Atlantic Avenue) can be brought to a halt as a result of pedestrian activity.

Crosswalks are available for all signalized crossings in the area as shown on the following Figure 3. Also, a number of other crosswalks are present at unsignalized locations throughout the area.

A series of pedestrian volume counts were conducted during July, 1983. Data was collected for the AM, Noon and PM periods for the central area bounded generally by Essex Street, Kingston Street, Federal Street and Summer Street. The data presented in Figures 4 through 6 indicate the major pedestrian crossings at the central intersections. A major pedestrian desire line links South Station with the High Street/Federal Street intersection and the Financial District beyond. Pedestrian activity is also very heavy along the entire length of Summer Street leading to the Downtown Crossing. More minor pedestrian corridors are located along Essex Street, South Street, Lincoln Street and Atlantic Avenue.

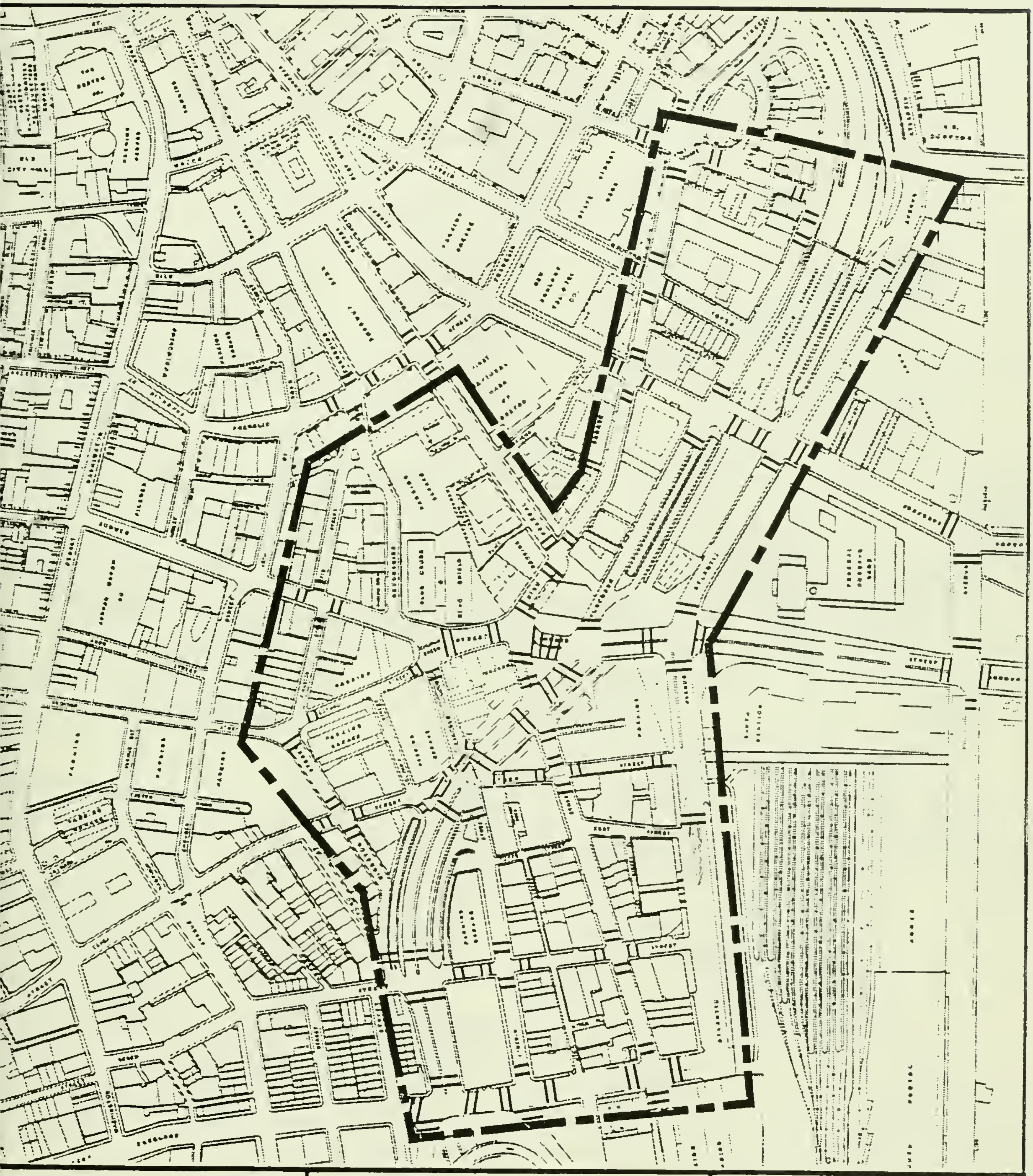

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Figure 3

Existing Pedestrian Crosswalks

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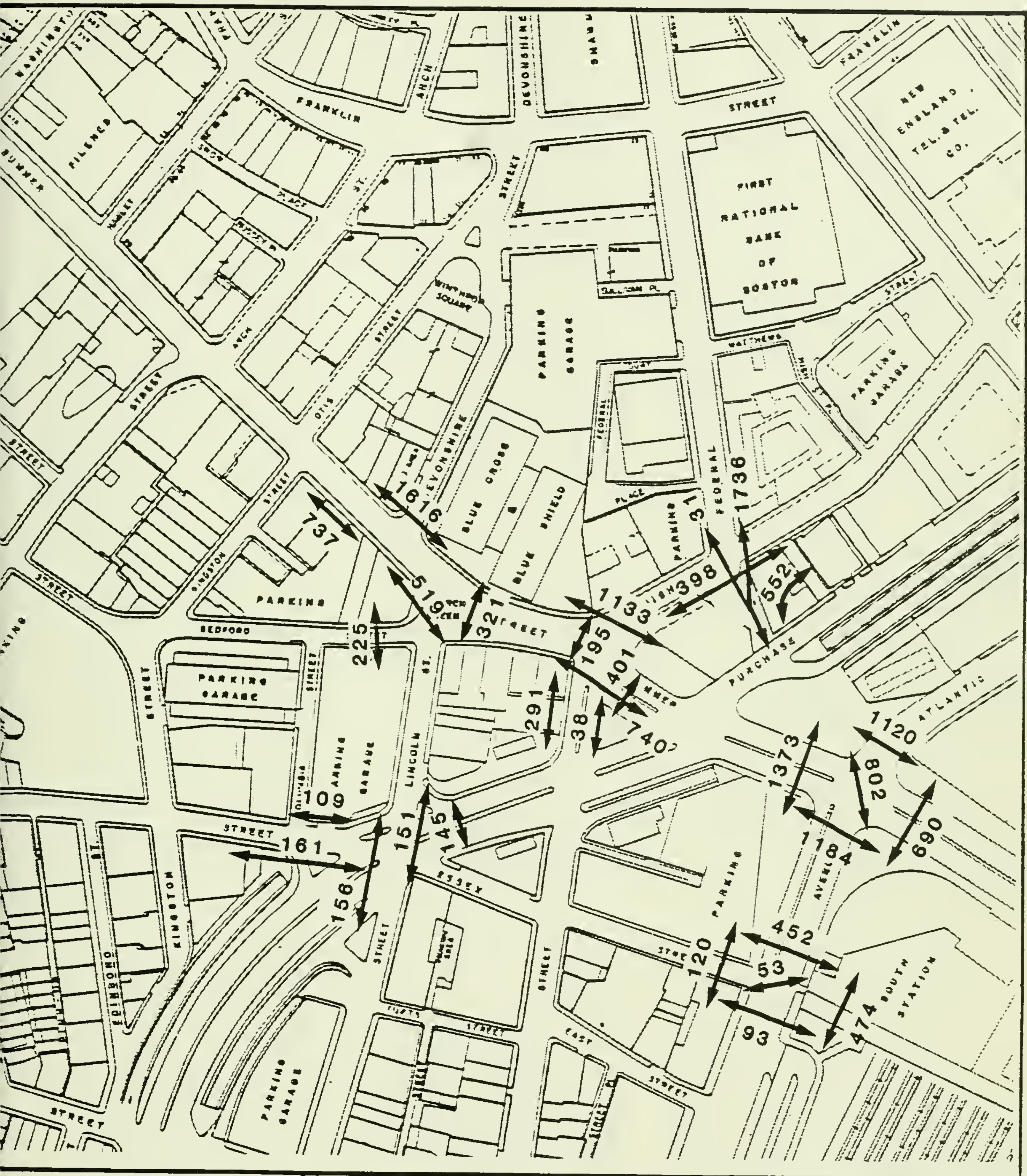

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Figure 4

Existing Pedestrian Flows
AM Peak Hour
7:30–8:30 AM

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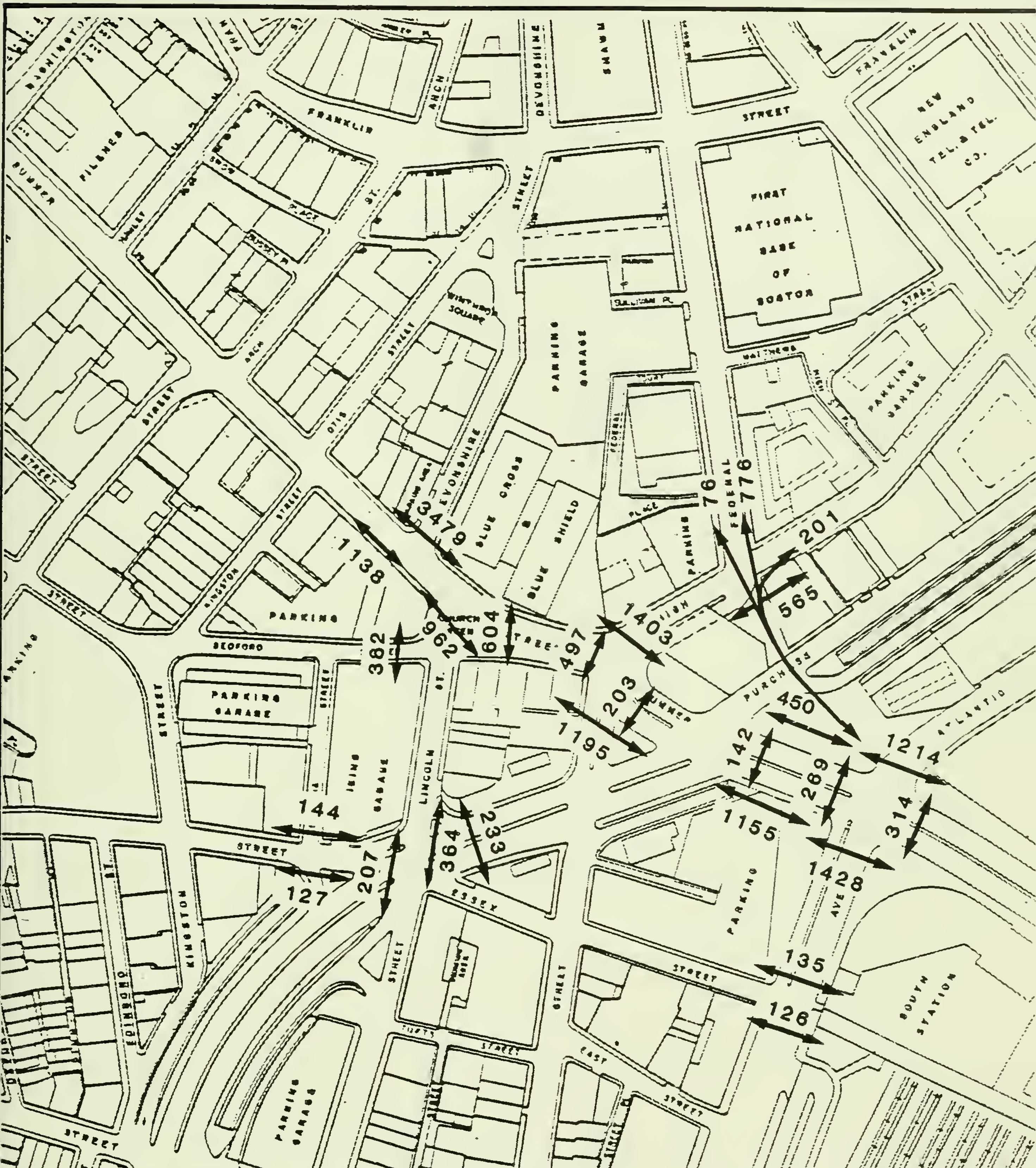

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Figure 5
Existing Pedestrian Flows
Noon Peak Hour
12:00–1:00

0 100 200
Scale in Feet

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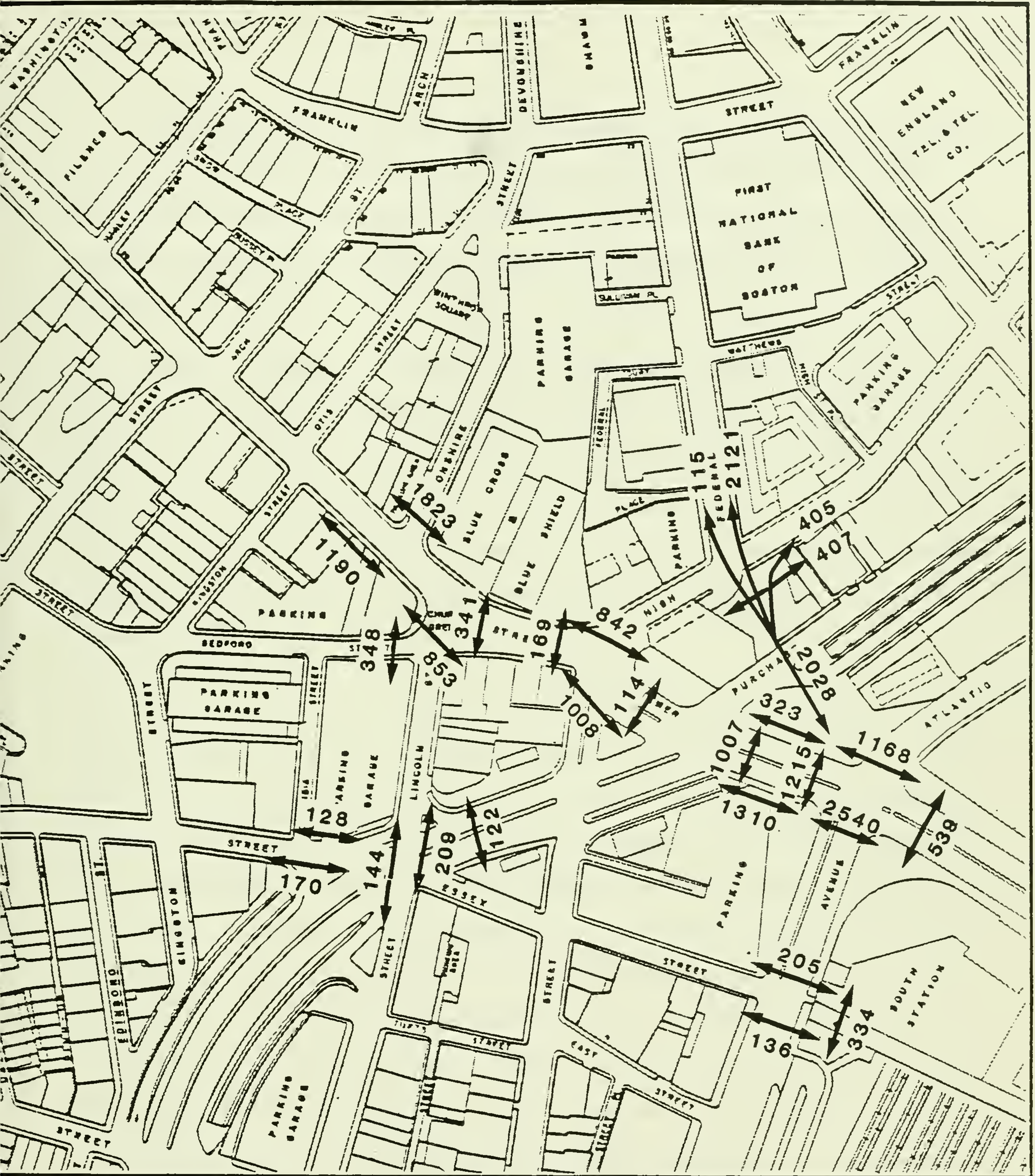

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Figure 6

Existing Pedestrian
PM Peak Hour
4:30–5:30

0 100 200
Scale in Feet

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The AM peak hour (7:30-8:30 AM) showed lower pedestrian volumes overall than the PM peak hour. This was expected as the AM peak period typically consists of worker trips while the PM peak period normally reflects a variety of purposes including work and shopping trips.

Summer Street was observed as having the highest AM pedestrian flows with over 2,350 people noted passing Devonshire Street (both sides). The Federal Street at High Street crosswalk northbound was observed serving approximately 1,760 pedestrians both sides, with most pedestrians on the east side of the street. Pedestrian usage on Essex Street west of Lincoln Street had 270 pedestrians on both sides of this facility.

During the noon peak period there were over 4,600 pedestrians noted along both sides of Summer Street at Devonshire Street. The majority of these pedestrians (3,400+) were observed on the north side of the street and this period represented the highest of the three observed. Summer Street, between Purchase Street and Atlantic Avenue had approximately 1,200 people crossing on the south side of the street. Federal and High Streets had approximately 850 pedestrians with over 770 of these on the east side of Federal Street. Construction on the northwest quadrant of the intersection may have influenced this very high use of the east side of Federal Street. With completion of the construction project, pedestrian flows may be more balanced on both sides of the street. Essex Street west of Lincoln Street had approximately 270 pedestrians during this hour with both sides of the street having an equal distribution.

In comparison to the AM peak period, overall pedestrian flows during the noon peak were higher on Summer Street and at Dewey Square, similar on Essex Street and lower at Federal/High Streets.

During the PM peak hour, Summer Street at Devonshire Street was observed carrying over 3,000 pedestrians with 1,800 on the north side and 1,200 on the south side of the street. Summer Street at High Street carried approximately 1,850 pedestrians with the majority using the south side of Summer Street. Federal Street at High Street had over 2,200 pedestrians crossing with the majority again on the east crosswalk. Essex Street west of Lincoln Street was observed carrying approximately 300 pedestrians.

E. CURBSIDE RESTRICTIONS

The majority of the curbside space in the Program Area is subject to a number of restrictions in terms of allowable use. Figure 7 was prepared to show, in overall terms, how the curbside space is utilized. The figure indicates that a portion of every street in the Program Area has either no parking anytime restrictions or is designated as a two zone. (Not shown on Figure 7 are bus stops and taxi stands).

Many of the posted parking restrictions are ignored by drivers. Double parking is a problem on some streets in the area including High, Lincoln and South Streets and Atlantic Avenue. The problem is created by a general shortage of short-term and on-street parking

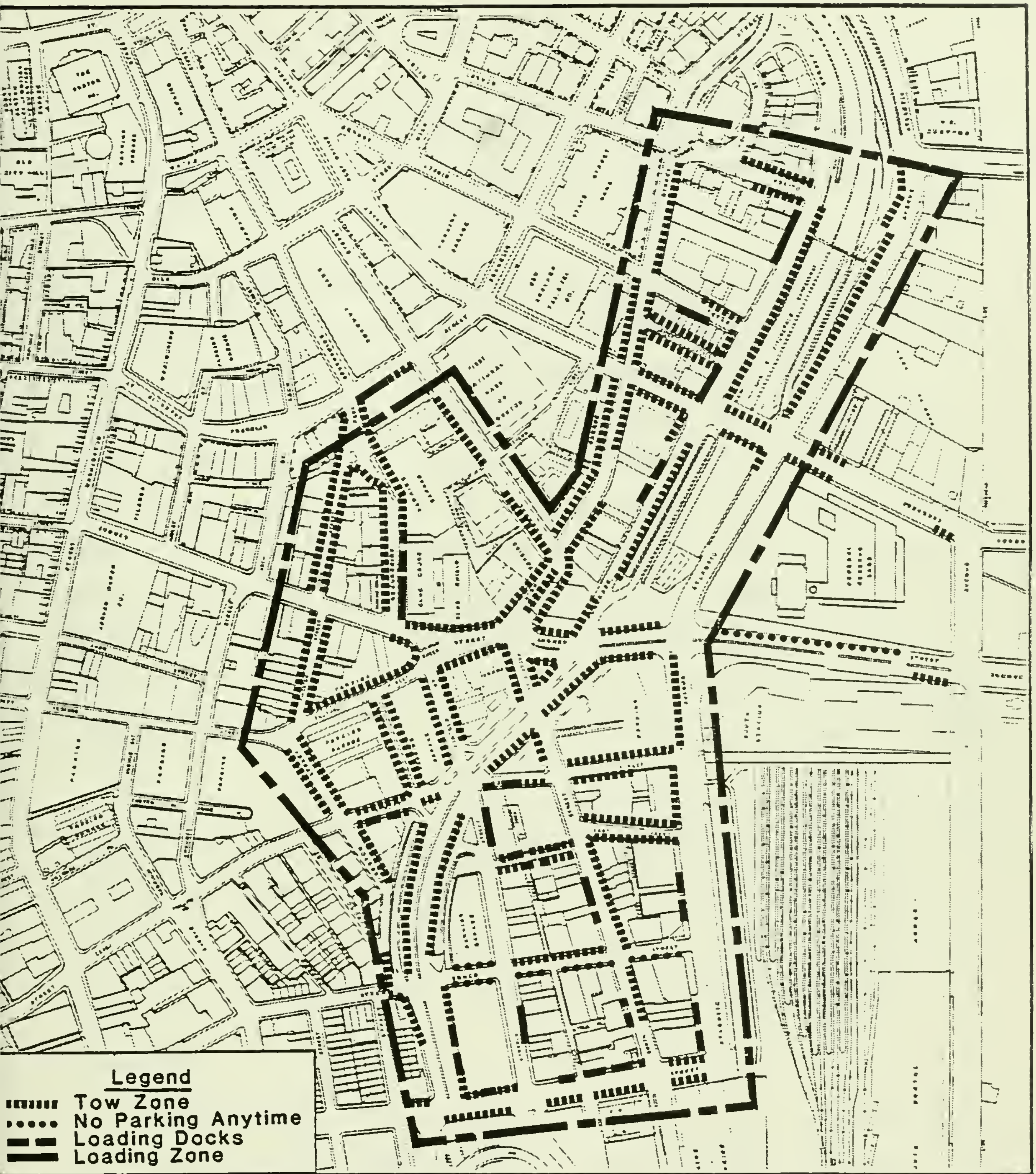

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Figure 7

Existing Curbside Restrictions

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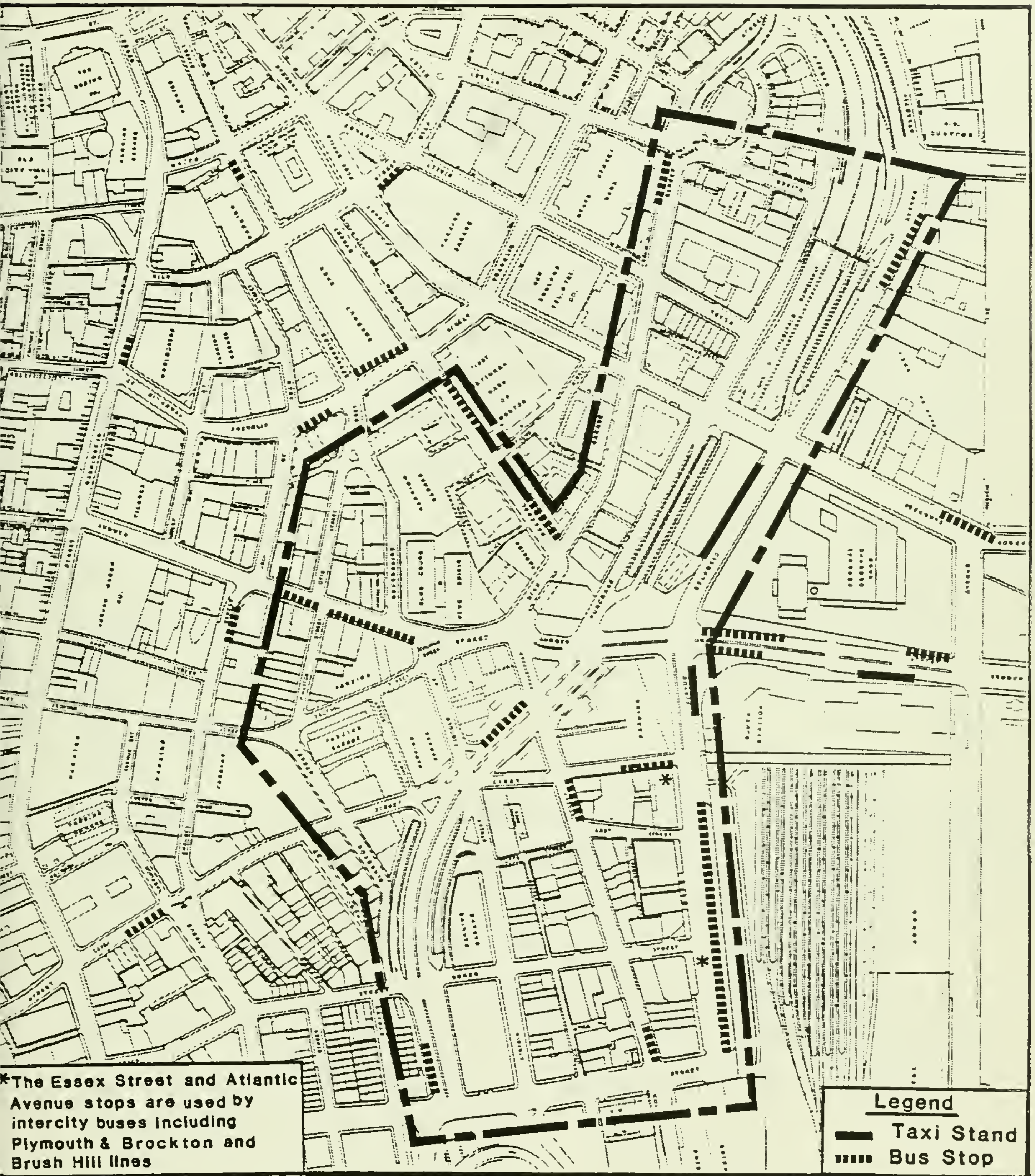
in the Program Area. However, with the recent increase in enforcement of the city's parking regulations, compliance with posted restrictions has gone up considerably.

Figure 8 was prepared to show existing bus stops and taxi stand locations throughout the area. A detailed description of the MBTA routes which service the designated stops appears in subsequent sections of this report. Bus stops are located along South, Federal, Franklin and Summer Streets as well as along the southbound side of the Surface Artery. These stops coincide with most of the MBTA express and local bus routes which service the area. The primary destinations are the stops adjacent to the First National Bank on Federal Street and the Shawmut Bank on Franklin Street. The figure also identifies bus stops on Summer Street east of Atlantic Avenue and on Atlantic Avenue north of Congress Street.

Portions of the east side of Atlantic Avenue adjacent to South Station and Essex Street and are also designated bus stops which are used by commuter carriers. Plymouth and Brockton and Brush Hill lines are the major operators of commuter buses which utilize the Atlantic Avenue loading areas adjacent to South Station.

F. TAXIS

Three major taxi stands are located in the Dewey Square program area, two on Atlantic Avenue and the other on Federal Street. Figure 8 ~~shown~~ noted previously indicates the location of the ~~stops~~ stands which are described below. A heavily used cab stand is located on the east side of Atlantic Avenue at South Station. Its patrons include



*The Essex Street and Atlantic Avenue stops are used by intercity buses including Plymouth & Brockton and Brush Hill lines

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Figure 8

Existing Bus Stop and Taxi Stand Locations

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rail travelers, Red Line passengers and workers in nearby buildings. Taxis leaving this stand have been observed to make a variety of illegal maneuvers because of the limited turning options north of Dewey Square. The second major taxi stand in the area is located on the west side of Atlantic Avenue adjacent to the Trailways Terminal and opposite the Federal Reserve Bank. The third cab stand is located on the northeast side of Federal Street, adjacent to the First National Bank of Boston. This stand primarily serves nearby buildings within the Financial District.

Outside of the program area is another taxi stand; this one located in front of Stone and Webster on the south side of Summer Street. Another major stand is located just outside the program area on Federal Street at the State Street bank building.

G. PARKING

Within the defined Program Area, there are a total of approximately 2,885 on- and off-street parking spaces. In conjunction with the posted curbside parking restrictions, only approximately 190 on-street curbside parking spaces are available. Streets with the greatest supply of on-street parking include Lincoln, South, and High Streets and Atlantic Avenue. The majority of these spaces are regulated by two-hour meters while approximately 50 are curbside spaces with no posted restriction.

Within the Program Area are three major off-street parking facilities containing 2,635 total spaces as well as a number of smaller lots. The major garages are located on the west side of

High Street between Congress and Federal Streets, on the block bounded by Federal, Franklin, Devonshire and Summer Streets and on the block bounded by Beach, Lincoln and Tufts Streets and the Surface Artery northbound. Figure 9 presents the available parking supply, by location and type. Off-street lots are primarily located along South Street, Essex Street, High Street and Purchase Street.

In addition to the supply described above, there are approximately 18 reserved spaces in the area -- 13 for the MBTA operations center on the west side of Purchase Street and five for the AMTRAK police on the east side of Atlantic Avenue adjacent to South Station. Approximately 10 curbside handicapped spaces are also located in the program area, all are north of South Station. The handicapped spaces are located on High, Federal and Pearl Streets. Just east of the Atlantic Avenue program area boundary are an additional 64 parking spaces on Congress Street, Summer Street and Dorchester Avenue. These spaces generally serve the Federal Reserve Bank, Stone and Webster, South Station and abutting businesses on Congress Street. Seven of these spaces on the south side of Summer Street are reserved for handicapped drivers.

On Atlantic Avenue at the temporary Continental Trailways Bus terminal are four (4) curbside spaces which have a posted 15-minute limit. These spaces are intended for short-term pick-up/drop-off at the bus terminal only.

During the morning peak period, a serious queuing problem exists along Federal Street between the Federal Street garage and

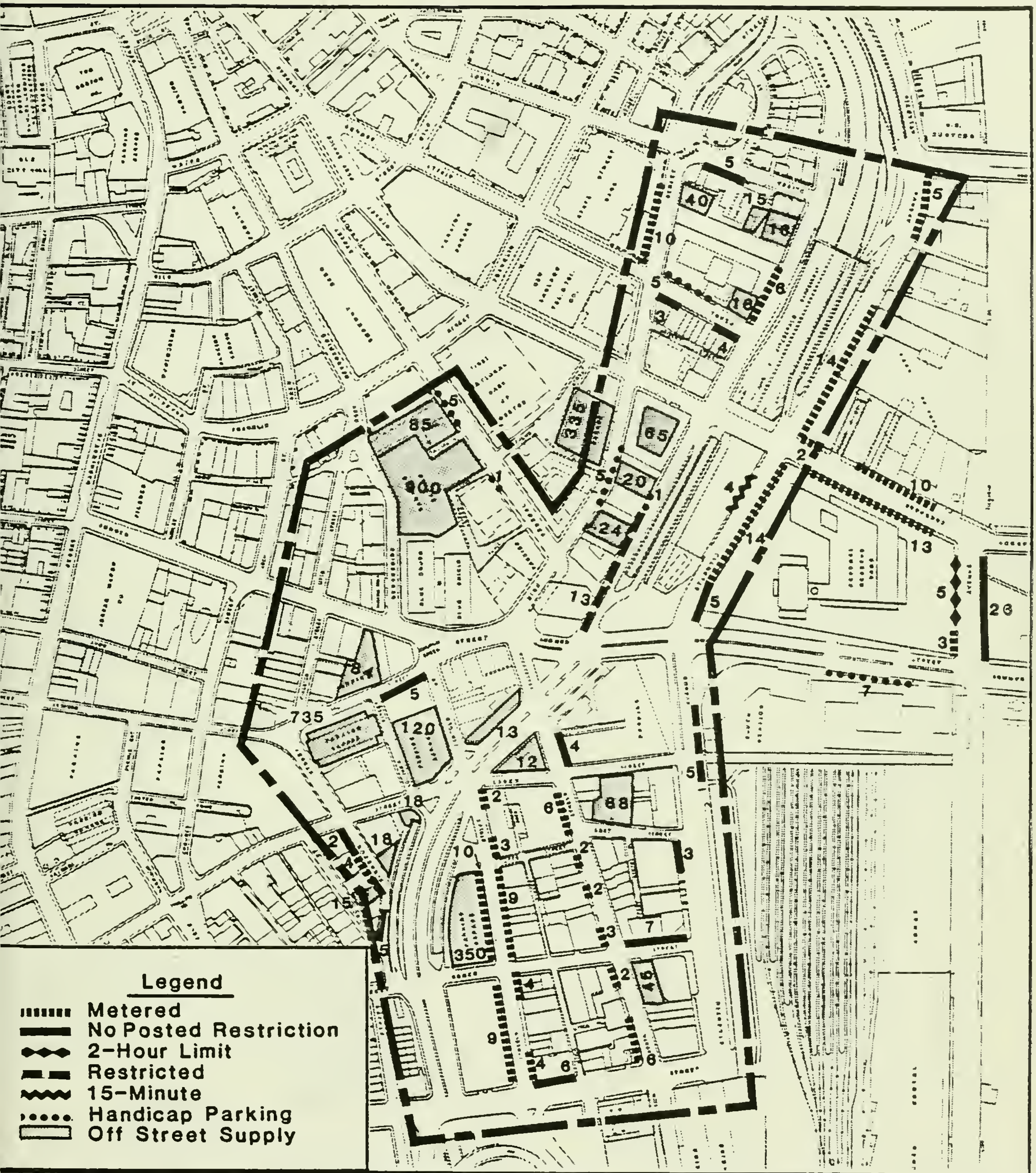

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Figure 9

Existing Parking Supply

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Scale In Feet

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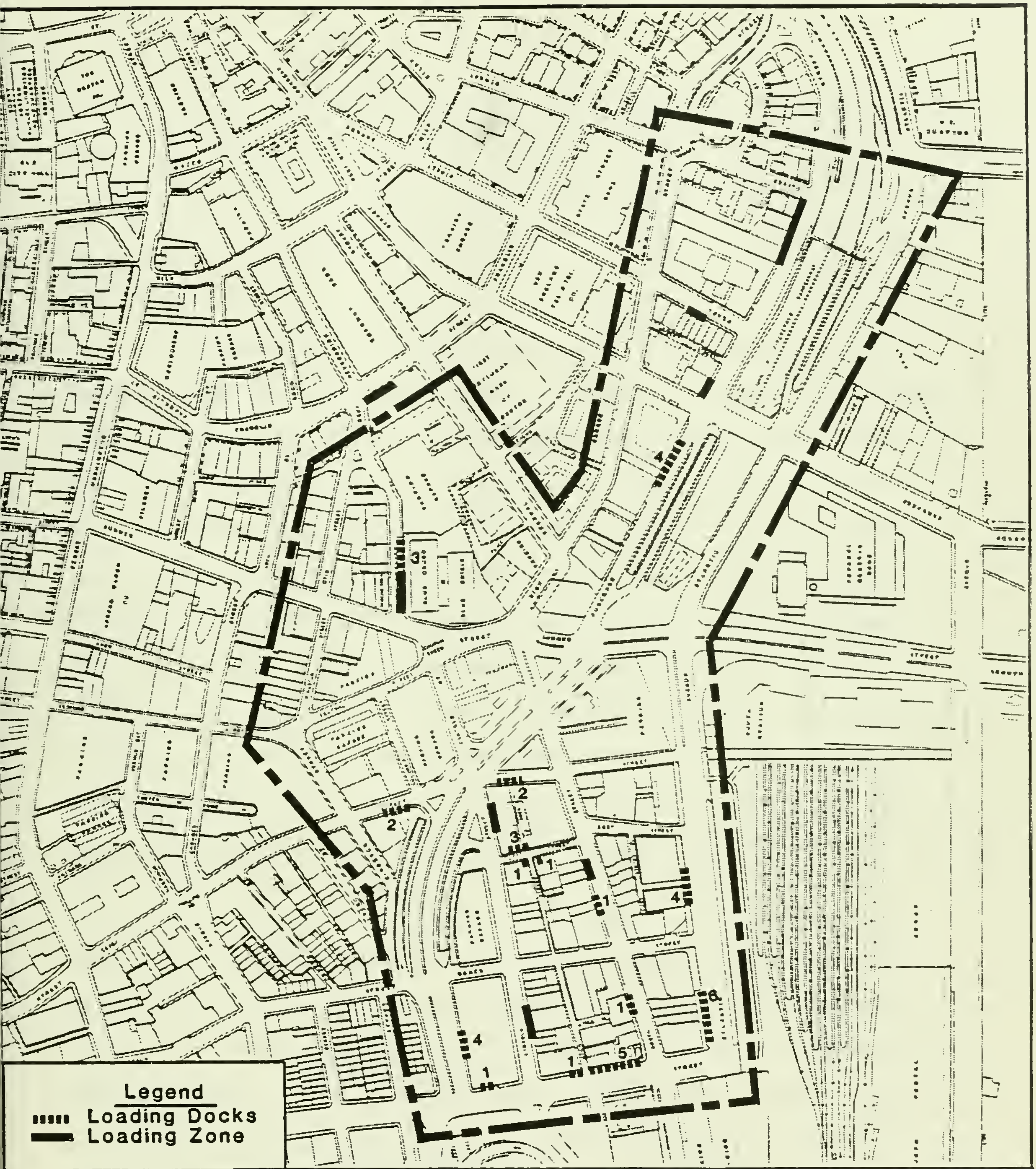

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Figure 10

Existing Posted Loading Areas

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lane for their loading operations. This activity reduces the available width for traffic flow and creates a degree of "side friction" which affects traffic flow. Also located in the Leather District are a series of loading docks along the north side of Kneeland Street.

A concentration of loading activity takes place at a series of loading docks on the southern end of Atlantic Avenue. When large semi-tractor trailers load at these docks, serious safety problems are created near the Atlantic Avenue/Kneeland Street intersection due to limited or blocked sight distance on this two way section. As part of this project, a telephone and field survey was made to contact tenants of the buildings which are used for trucking activity. Based on the reported use (frequency and size of vehicles), a detailed plan was developed to address the existing loading problems which would be affected by a change in Atlantic Avenue's direction to one-way northbound and by curb line changes. These recommendations are detailed in later sections of this report.

Other loading activities take place along Purchase Street. Truck activity at the intersection of Surface Artery and Oliver Street during the morning peak hour occasionally interferes with the flow of traffic headed east on Oliver Street from the High Street Central Artery southbound off-ramp. This loading takes place at the western end of the pedestrian overpass and combined with operation of the pedestrian signal at the Centeral Artery overpass, creates congestion which causes queuing on the southbound off-ramp.

Typically, the ramp queues approximately half way up to the Central Artery and occasionally, the queue reaches the Artery itself. Loading operations at the Purchase Street/Congress Street intersection occasionally interferes with the signal at this location while south of Congress Street, loading has virtually no effect on traffic due to the relatively low volumes on this link.

Within the study area, two other streets have loading docks and designated loading zones. They are Essex Street east and west of the Surface Artery and Devonshire Street north of Summer Street adjacent to the Blue Cross and Blue Shield Building. Many of the Program Area's streets are used for trucking activity where no designated loading zones are identified, particularly on Lincoln Street, High Street and East Street. Loading is usually accomplished while a vehicle is either illegally or double parked.

I. DANGEROUS MATERIALS

Transportation of dangerous materials is prohibited in the Dewey Square Tunnel. Dangerous materials are considered to include the following types of materials: flammable liquids, flammable compressed gases, poisonous materials, and explosives. As a result, it is necessary for trucks carrying these materials to exit from the regional highways onto local city streets and bypass the tunnel. Figure 11 was prepared to show the limited number of alternative routes which are available and generally used by truckers.

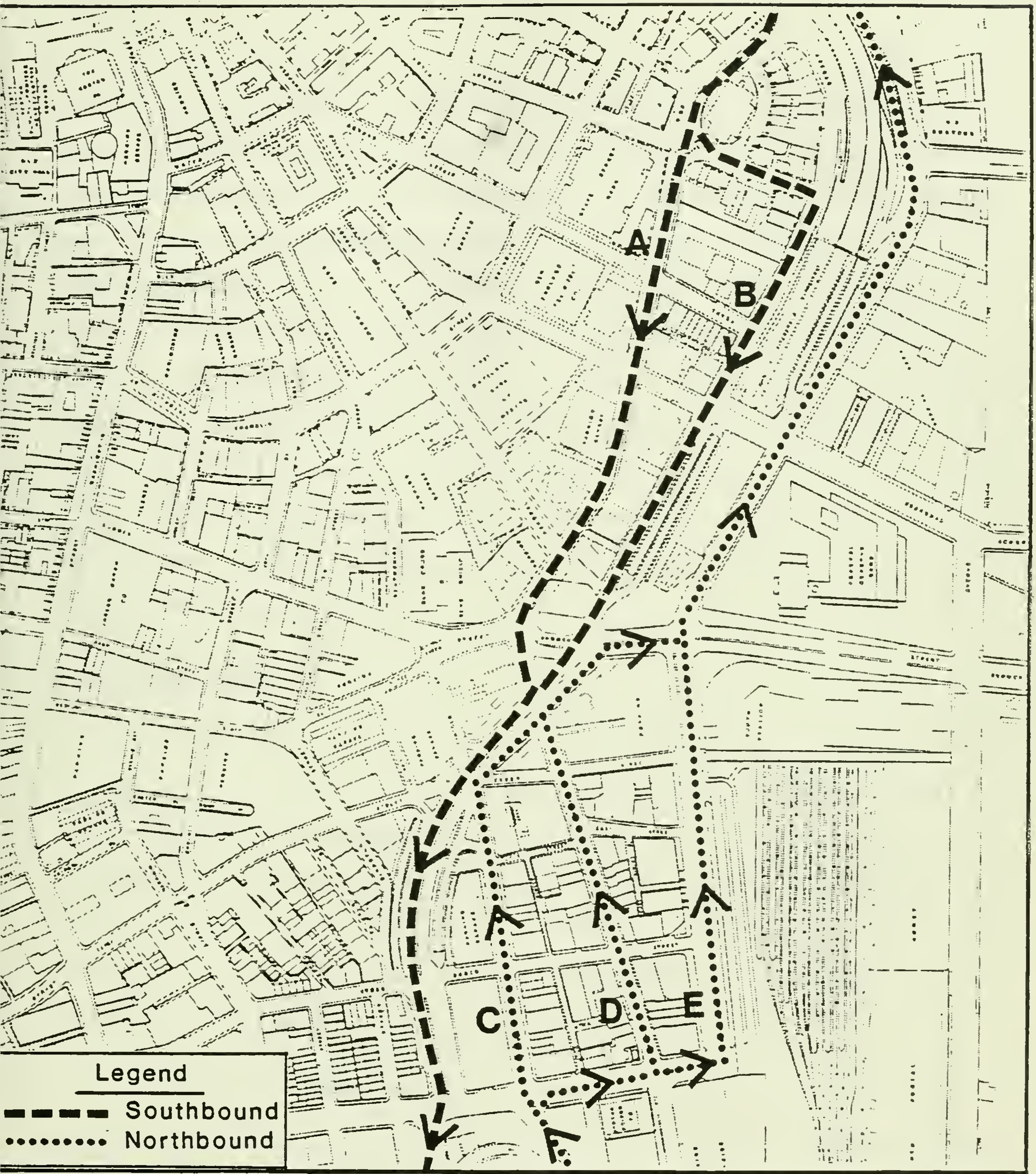

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Figure 11
Hazardous Materials Truck Routes

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materials as a result of the number of conflicts that are encountered including parking, truck loading and bus operations. Also, restricted geometry at the intersections with Surface Artery and at the Atlantic Avenue/Summer Street intersection contribute to lower usage of Routes C and D. Route E - Atlantic Avenue is the primary choice of most drivers carrying explosive or flammable materials. Two factors influence this choice: 1) the greater width of Atlantic Avenue and the consequent reduction in the number of conflicts, and 2) the better alignment of this alternative route. Among the buildings exposed to hazardous materials on this route are South Station, the Federal Reserve Building, the Dewey Square Office Tower and the Russia Wharf building.

J. FIRE ACCESS

A Boston Fire Department Station is located on Oliver Street at the north end of the Program Area. This station is the closest to Dewey Square and houses Division 1, Rescue 1, Engine Co. 10. Figure 12 was prepared to show major routes followed in response to a fire within the program area. The figure indicates that High and Purchase Streets offer the primary routes into the area with turns possible at major intersecting streets.

Fire engines leaving the station for points to the north use High Street Place and go through the Atlantic Avenue/Surface Artery/ High Street intersection in a direction opposite the normal flow of

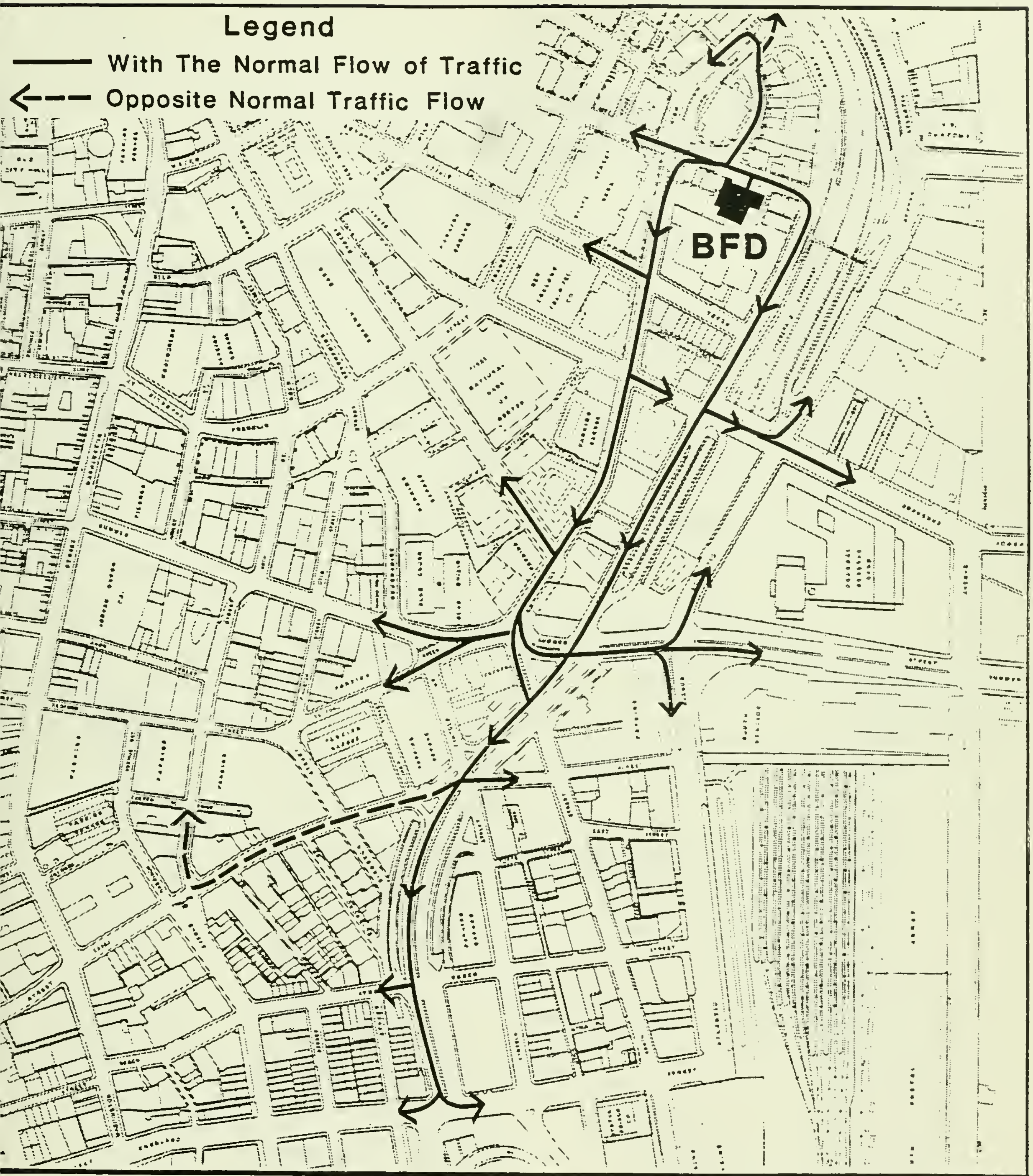

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Figure 12
Boston Fire Department Response Routes

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traffic. In responding to a fire or emergency, emergency vehicles also use Essex Street west of the Surface Artery in the opposite direction of normal traffic flow.

K. EXISTING MBTA SERVICE

The Program Area is served by nine different surface bus routes. Four routes provide local service within Boston while the other five provide Express bus service between Downtown and outlying suburbs along the Mass. Turnpike. Figure 13 identifies the existing routes within the program area and Table 2 summarizes each route by name, number and type of service.

TABLE 2
EXISTING MBTA SURFACE BUS ROUTES

Route Number	Name	Type of Service
06, 06-1	Army Base - Haymarket/South Station	Local
07	City Point - Downtown	Local
11	City Point (Bayview) - Downtown (Essex/Washington)	Local
49	Northampton Station - Downtown	Local
300	Riverside - Downtown	Express
301, 301-1	Brighton Center - Downtown	Express
304, 304-1	Watertown - Downtown	Express
305	Waltham - Downtown	Express
310	Needham - Downtown	Express

traffic. In responding to a fire or emergency, emergency vehicles also use Essex Street west of the Surface Artery in the opposite direction of normal traffic flow.

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304, 304-1	Watertown - Downtown	Express
305	Waltham - Downtown	Express
310	Needham - Downtown	Express

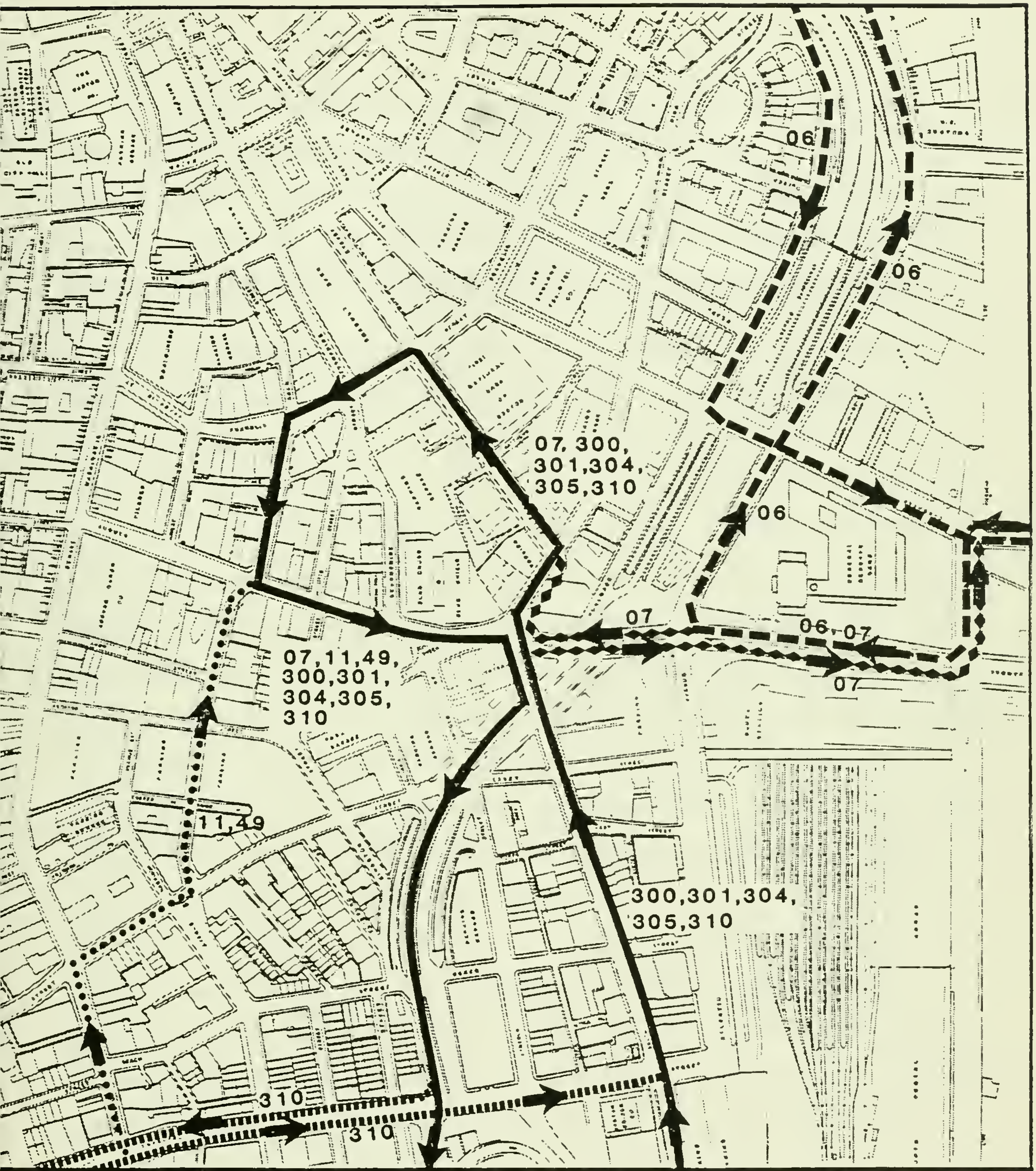

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Figure 13

Existing MBTA Surface Bus Routes

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Scale in Feet

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Route 06 provides local service between Haymarket, South Station and the Boston Army Base while Routes 7 and 11 serve South Boston between City Point and Downtown on two different travel routes. Route 49 also provides local service between Northampton Station on the Orange Line and Downtown via Washington Street.

Four of the five express bus routes travel the same streets to reach the Downtown Financial District. The general pattern is a counterclockwise loop with buses entering the area at the South Street Turnpike off-ramp. Express buses cross Kneeland Street and proceed north on South Street to High Street. Current practice is for the express buses to use a short contraflow bus lane on High Street to reach Federal Street (particularly during the morning). All buses turn left on Federal Street and complete their loading at the two major stops (The First National Bank on Federal Street and the Shawmut Bank on Franklin Street). To leave the Financial District, all five express buses and local Route 7 turn left into a contra-flow lane on Arch Street and then left again onto Summer Street. From this point, the express buses turn right onto South Street and from there, turn right onto the Surface Artery southbound. Major stops are also located on Summer Street at Otis Street, on the Surface Artery between South and Lincoln Streets an on the Surface Artery at the Kneeland Street intersection. Figure 8 presented previously summarizes the existing bus stop locations within the program area.

TABLE 3
EXISTING MBTA SERVICE
WEEKDAY TRIP SUMMARY
WINTER, 1983 SCHEDULE

LOCAL SERVICE

	7:00 AM - 8:59 AM		9:00 AM - 2:29 PM		2:30 PM - 5:29 PM		5:30 PM - 7:00 AM		All Day	
Route[1]	In	Out	In	Out	In	Out	In	Out	In	Out
06,06-1	10	9	10	8	11	8	8	7	39	32
07[2]	21	21	19	20	16	18	16	15	72	74
11	12	12	24	24	18	17	19	23	73	76
49	3	3	6	6	4	4	3	3	16	16
Subtotal	46	45	59	58	49	47	46	48	200	198

EXPRESS SERVICE

	7:00 AM - 8:59 AM		9:00 AM - 3:59 PM		4:00 PM - 5:59 PM		6:00 PM - 6:59 AM		All Day	
Route	In	Out	In	Out	In	Out	In	Out	In	Out
300	24	26	22	24	22	26	20	24	88	100
301, 301-1	46	41	27	32	40	57	24	31	137	161
304, 304-1	20	22	18	20	20	27	18	20	76	89
305	26	29	25	27	27	34	25	27	103	117
310	25	2	7	9	6	22	8	6	46	39
Subtotal	141	120	99	112	115	166	95	108	450	506
TOTAL	187	165	158	170	164	213	141	156	650	704

Source: MBTA Systems Planning Office

[1] Where discrepancies existed between route summaries and schedule information, the schedule was used to determine trips.

[2] Some of these vehicles shuttle only between South Station and Downtown.

TABLE 4
MBTA LINE STATISTICS
WEEKDAY TRIP SUMMARY
WINTER, 1983 SCHEDULE

LOCAL SERVICE

		AM		Base		School Peak		PM	
oute		Vehicles	Headway	Vehicles	Headway	Vehicles	Headway	Vehicles	Headway
	Army Base - South Station	1	30	- - - - (Peak Hours Only) - - - -				1	30
-1	Army Base - Haymarket	2	30	- - - - (Peak Hours Only) - - - -				2	30
	City Point - Downtown	4	12	2	30	2	30	4	15
1	City Point - Downtown	9	7	4	15	5	12	8	9
9	Northampton Sta. - Downtown	1	50	1	50	1	50	1	50

EXPRESS SERVICE

		AM		Base		School Peak		PM	
oute		Vehicles	Headway	Vehicles	Headway	Vehicles	Headway	Vehicles	Headway
300	Riverside - Downtown	8	7	(Peak Hours Only)		1	X	8	7.5
301	Brighton Ctr. - Downtown	9	6	- - - - (Peak Hours Only) - - - -				9	7
304	Watertown - Downtown	8	7.5	2	30	2	30	7	10
304-1	Newton Corner - Downtown	7	7.5	1	30	1	30	6	10
305	Waltham - Downtown	8	10	- - - - (Peak Hours Only) - - - -				8	10
310	Needham Jct.- Downtown	12	5	2	60	3	30	13	7.5

Source: MBTA Systems Planning Office.

Notes: All headways are reported in minutes.
Route 6-1 operates between Army Base and Haymarket via South Station.
Routes 304/304-1 both provide express service through Newton Corner.
Routes 310 listed in this table includes only buses running from Needham to Downtown (Franklin and Arch Streets).
PM School Peak: 1:20-2:25 PM
X = Irregular Service

2. Ridership

In addition to scheduling and route information, the MBTA was able to provide a significant amount of information regarding passenger volumes by route. This data is generally available on a disaggregate level which indicates total passengers on each bus observed. To simplify the presentation of this data, it was aggregated and summarized to produce the following two tables. Data is presented for each of the major peak periods of the day, generally 6:00-10:00 AM and 2:00-7:30 PM. Heaviest commuter hours within those periods are between 7:00-9:00 AM and 3:30-5:30 PM.

In Table 5 The number of passengers entering the program area is listed first, followed by the number of passengers leaving the program area during each peak period. The results indicate that together, the five express bus routes typically carry approximately 4,400 passengers during each of the peak periods. Of this total, the vast majority (approximately 95 percent) enters the program area during the AM peak period. Similarly, during the PM peak period, 95 percent of the riders leave the area. All totaled, the five express routes carry over 8,800 passengers on a typical weekday during the two commuter peaks. In addition to this total, Routes 304, 304-1 and 310 provide off-peak service and together carry approximately 700 riders during the midday off-peak period. Thus, between 6:00 AM and 7:30 PM, the five express routes carry approximately 9,500 passengers on a typical weekday.

TABLE 5
EXPRESS BUS PASSENGER VOLUMES
FEBRUARY, 1982

Route	AM Period 6:00-10:00 AM In	AM Period 6:00-10:00 AM Out	PM Period 2:00-7:30 PM In	PM Period 2:00-7:30 PM Out	Total In	Total Out
300[1/]	755	72	43	867	798	939
301	877	4	11	766	888	770
304	1,119	79	148	1,259	1,267	1,338
305	617	38	22	507	639	545
310	868	16	25	740	893	756
Total	4,236	209	249	4,139	4,485	4,348

[1/] Outbound and PM volumes on Route 300 taken January, 1983.

Data on the local bus route passenger volumes (Table 6) indicates that during the AM and PM peak periods, between 2,100 and 2,300 passengers are carried on the four local routes. In comparison with the express routes, the local routes carry approximately one-third of the bus passengers entering the program area during peak periods. On a daily basis (5:00 AM to 6:30 PM), the four local routes carry approximately 6,000 passengers.

When local and express services are combined, a total daily ridership of approximately 16,000 individuals is carried by the nine routes.

TABLE 6
LOCAL BUS PASSENGER VOLUMES

Route	AM Period 5:00-9:29 AM		Midday 9:30 AM-2:59 PM		PM Period 3:00-6:29 AM		Total	
	In	Out	In	Out	In	Out	In	Out
6	99	152	-	-	281	12	380	164
7	428	418	248	178	110	481	786	1,077
11	1,001	129	435	720	200	959	1,636	1,791
49	42	8	81	34	35	48	158	90
Total	1,570	690	764	932	626	1,500	2,960	3,122

1/ Routes 6 and 7 passenger volume counts taken June, 1982.
2/ Route 11 passenger volume counts taken September, 1982.
3/ Route 49 passenger volume counts taken March, 1981.

L. DAILY TRAFFIC VOLUMES

Daily traffic volume data from previous transportation studies in the area were collected and reviewed as part of this project. Sources of this data include recent environmental impact reports (EIR's), the 1982 Boston Cordon Count, the Massachusetts Department of Public Works (MDPW), the Central Artery Origin-Destination Survey (1977), and several counts conducted by Vanasse/Hangen Associates. No new daily or peak hour data was collected as part of this Dewey Square Comprehensive TSM study.

Table 7 summarizes daily traffic volume information by location and date. The majority of the information in the table was collected during the 1977 O-D study. Due to the six-year period which has passed since then, the data should only be used for a comparison of the relative levels of traffic on each roadway.

TABLE 7
AVERAGE DAILY TRAFFIC VOLUME SUMMARY

Location	Year	ADT
Atlantic Ave. between Summer & Congress	1982	16,900
Atlantic Ave. south of Northern Ave on-ramp	1977	15,300
Summer Street at Ft. Point Channel	1981 1982 1982	25,900 27,000 28,140
Summer St. Southbound off-ramp	1977	8,300
Dorchester Ave. north of Summer St.	1977	16,500
Congress St. at Ft. Point Channel	1981 1982	9,900 11,900
Congress St. over Central Artery	1977	18,100
Congress St. between Purchase & High	1977	8,600
Congress St. northbound on-ramp	1977	9,800
Congress St. southbound on-ramp	1977	5,900
High St. between Federal & Congress	1977	4,100
High St. between Pearl & Congress	1977	7,300
High St. between Oliver & Pearl	1977	11,200
High St. between Batterymarch & Oliver	1980 1977	5,400 5,200
High St. southbound off-ramp	1977	10,200
Oliver St. between Franklin and High	1980	4,300
Purchase Street north of Congress St.	1977	9,400
Purchase St. just south of High St.	1977	18,000
Purchase St. southbound on-ramp (at Oliver St.)	1977	9,400
Purchase St. between Congress and Summer	1977	2,800
Mass. Pike/South St. northbound off-ramp	1977	9,300
South St. north of Kneeland St.	1978	6,100
South St. between Essex and Surface Artery	1977	3,600
South St. northbound on-ramp	1977	9,800
Kneeland St. between Lincoln & South	1977	9,500
Kneeland St. west of Hudson St.	1977	17,800
Kneeland St. northbound off-ramp	1977	19,900
Kneeland St. southbound on-ramp	1977	16,500
Surface Artery north of Kneeland St.	1978	23,800
Beach St. southbound off-ramp	1977	3,900
Beach St. between Lincoln & Surface Artery	1977	1,400

In several cases, counts were made during different years and that data is also presented, where available. At the three locations where data from more than one year is presented, the effects of general traffic growth is clearly evident.

A review of the volumes points out that two major streets (Summer Street, Surface Artery) carry volumes in excess of 20,000 vehicles per day (vpd). Several others carry in excess of 15,000 vpd including Atlantic Avenue, Dorchester Avenue, Congress Street, Purchase Street and Kneeland Street. The majority of the remaining streets carry between 4,000 and 6,000 vpd.

PROPOSED AREAWIDE TRAFFIC IMPROVEMENTS

Three ~~Two~~ independent ongoing roadway improvement projects that will affect Dewey Square are currently under design or design. ~~Neither project is~~ None of these are funded through the Dewey Square TSM grants. The first is the ramp and 500-space parking deck construction related to the South Station Transportation Center (SSTC). This project, being built for the MBTA as part of the Northeast Corridor Improvement Project (NECIP), will provide both direct and indirect connections for bus and service traffic from the Turnpike and Southeast Expressway to SSTC. The SSTC project also includes the construction of a pair of helices at the southern end of Atlantic Avenue, opposite Kneeland Street. These helices will serve auto traffic exiting from the proposed parking deck while all traffic entering the parking deck will be from the first curb cut north of the helices on Atlantic Avenue. As a result of this plan, all exiting traffic would leave the parking garage at the Kneeland Street/Atlantic Avenue intersection.

The second area roadway project includes reconstruction and signalization improvements by the City of Boston for the roadways adjacent to the Lafayette Place Development. A new roadway, Avenue de Lafayette would be built between Essex and Washington Streets where Exeter Place and Rowe Place currently exist. The Lafayette Place development is planned to open in the fall of 1984 and the associated roadway improvements are expected to be complete by ~~that~~ that time.

time.

A third improvement scheduled to be implemented is the widening and designation of Essex Street as a two-way street between Atlantic Avenue and Surface Artery. This improvement is being constructed, in part, in conjunction with the Dewey Square Tower (One Financial Center) project.

Because of the significant degree of interagency planning, these ~~both~~ projects will be compatible with the improvements proposed under the Dewey Square TSM project.

DESCRIPTION OF ALTERNATIVES

The goals of the Dewey Square project are aimed at improving the study area through upgraded geometry and signalization. While the SSTC and Lafayette Place roadway improvements have moved ahead, two alternatives for reconfiguring the Dewey Square roadway system have also been developed by the BRA over the past several years. These concepts, hereinafter referred to as Alternatives A and B, were developed to a conceptual level only. It is the purpose of this study to refine those concepts and to address a number of design issues.

A. GENERAL DESCRIPTION

Each alternative is described briefly, followed by a more detailed description in the next section. The main concept of Alternative A is to create a series of one-way streets in the Leather District/South Station area. Atlantic Avenue and Lincoln Street would carry northbound traffic while South Street and Surface Artery would accommodate southbound traffic only. In addition to this change, Essex Street would be widened and improved to carry two-way traffic. These major improvements would make a number of other changes to existing traffic patterns possible at the Summer Street/High Street and Surface Artery/South Street/ Purchase Street intersections.

Alternative B features the same improvements as Alternative A with the addition that High Street would be reversed between Summer and Pearl Streets. With this arrangement, the area roadway network

would be considerably simplified and considerable improvements could be made. The link between High Street and the Surface Artery would therefore be eliminated at the south end of this corridor. Several options are available to accommodate traffic at the northern end of the corridor including use of a fixed traffic diverter or a more major relocation of the High Street off-ramp from the Central Artery.

B. ALTERNATIVE A

The major design features of Alternative A are indicated in Figure 14. As currently planned, the improvements include the following:

- Surface Artery becomes a four-lane, one-way southbound roadway between Summer and Kneeland Streets. In the vicinity of Teradyne, between Beach and Kneeland Streets, the loading area would be redesigned to accommodate Teradyne's trucking activity.

- Between Essex and Kneeland Streets, Atlantic Avenue is a one-way northbound roadway featuring three travel lanes, a curb drop-off/parking lane on the east side and provisions for truck loading on the roadway's west side.

- A bus prioritization system would be created along Atlantic Avenue and Summer Street for MBTA buses entering the program area. The westernmost lane on Atlantic Avenue adjacent to the Dewey Square Tower at Summer Street would

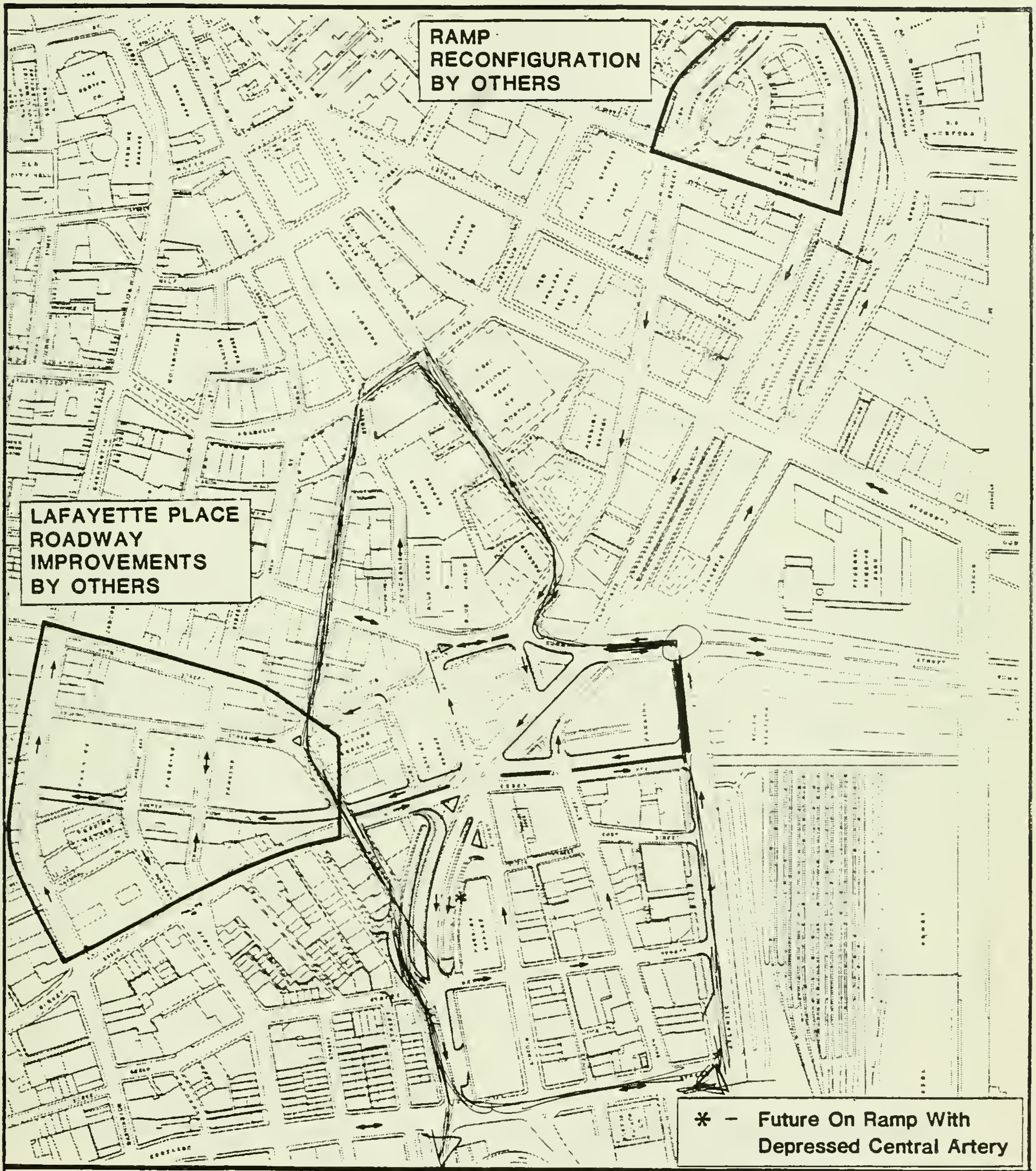
RAMP RECONFIGURATION BY OTHERS
LAFAYETTE PLACE ROADWAY IMPROVEMENTS BY OTHERS
* – Future On Ramp With Depressed Central Artery

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Figure 14

Alternative A
Roadway Network

| = exclusive bus lanes

O priority at signals

0 100 200
Scale in Feet

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be channelized and restricted to MBTA bus use only. A signal phasing pattern which gives highest priority to these buses would be implemented.

- Because of the preferential signal phasing for buses at Atlantic Avenue, left turns from Atlantic Avenue to Summer Street would be prohibited by channelization. Also incorporated into this signal phasing plan would be an exclusive pedestrian phase which allows pedestrians to cross at the Summer/Atlantic intersection without interference from moving vehicles.

- Essex Street would be widened to 72 feet between Atlantic Avenue and South Street, providing three 33-foot lanes per direction and a 6-foot median. The curbside lane would be used for parking or as bus layover space. Between Surface Artery and Kingston Streets, the roadway would be six lanes wide with three travel lanes per direction.

see page 51. green?

- The northbound on-ramp from the Surface Artery/South Street intersection to the Central Artery would be relocated directly opposite South Street and the link of South Street between Essex Street and Surface Artery would be eliminated.

- The portion of South Street between Kneeland and Essex Streets could be one-way southbound. It would be

desirable, however, to allow South Street to function as a one-way northbound street for reasons described in the following sections.

- Beach, Kingston and Edinboro Streets would be closed to through traffic in the Chinatown area. An emergency access roadway would pass through the ceremonial arch on Beach Street to provide a route for fire engines, ambulances, and other emergency vehicles. This roadway could be constructed similar to Washington Street in the Downtown Crossing auto restricted zone (ARZ) and only limited emergency access would be provided to these streets.

- Lincoln Street remains one-way northbound, however the section between Purchase and High Streets becomes much more critical since it would have to accommodate much of the traffic that uses the parallel section of South Street which will be closed.

- Bedford Street would be closed between Lincoln and Columbia Streets.

- The direction of High Street would remain as existing: one-way southbound between Purchase and Federal Streets and two-way between Federal and Summer Streets. The southbound link of High Street between Summer Street and Surface Artery would remain under Alternative A.

- Summer Street would carry two way traffic from High Street to Kingston Street. Only westbound traffic would be carried on the High Street to Purchase Street link. Between Purchase Street and Atlantic Avenue, two directions would be carried on Summer Street and a separate bus only lane would be located in the center of the roadway.

- MBTA Buses leaving the Dowtown Crossing would travel from the stops at the Shawmut and First National Banks via Franklin, Otis and Kingston Streets. At Kingston Street, several options were studied to move buses from Kingston Street to Surface Artery near the Beach Street off-ramp. A bus stop would be located near the new transit way and Surface Artery, replacing the existing stop on Surface Artery at Kneeland Street.

C. ALTERNATIVE B

Under Alternative B, many of the design features are similar or identical to Alternative A. Figure 15 indicates the Alternative B roadway network. For discussion purposes, only those features which distinguish this plan from Alternative A are listed.

- The primary difference between the two alternatives is that the direction of High Street is reversed. Its current one way southbound pattern between Purchase and Federal Streets and two way pattern between Summer and Federal Streets would change to one way northbound between Summer and Pearl Streets.

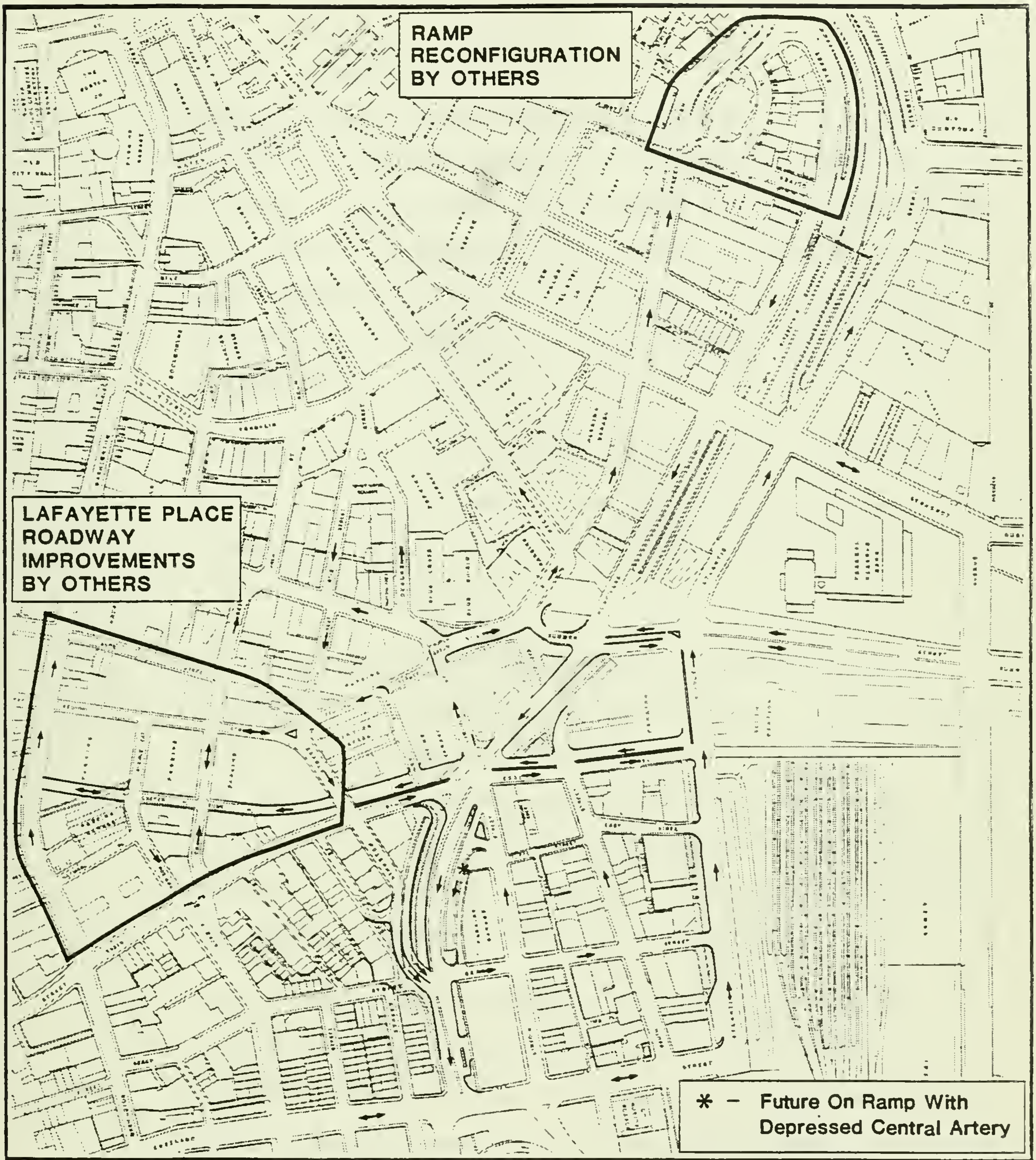
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Figure 15

Alternative B
Roadway Network

0 100 200
Scale in Feet

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- Several options for accommodating traffic at the Pearl Street end of High Street are discussed in following sections. The preferred solution is the relocation of the High Street Southbound off-ramp from the Central Artery. This improvement will be made possible by the proposed International Place project on the parcel bounded by Oliver Street, Purchase Street and High Street.

- The South Street link between Summer Street and Surface Artery is closed, creating additional pedestrian and development spaces. This is primarily possible due to the reversal of High Street.

- The northbound lane of High Street adjacent to the Fiduciary Trust Building (Bay Bank/Boston) is designated as a curb loading/drop off area only. All traffic flows are carried on the west side of the existing traffic island. On the south side of the building, it would be necessary to modify the geometry of the existing curblines and possibly affect the planted plaza area there.

- Summer Street would become one way eastbound between Lincoln and High Streets and one way westbound between Lincoln and Otis Streets. The short eastbound segment of Summer Street between High and Purchase Streets would also be closed.

D. MODIFICATIONS OR REVISIONS TO THE ALTERNATIVES

1. General

The MEPA Certificate dated June 7, 1983 requests that a description of all alternatives considered be provided in the text or in an appendix. It further goes on to ask about the implications of altering the one-way street pattern in the vicinity of the China Gate. It should be pointed out that the initial development of Alternatives A and B was as a result of some broad goals to simplify the area's existing traffic problems. Those goals led to the development of the basic concept that buses should be given as much preferential treatment as possible, that Atlantic Avenue and Lincoln Street should be one-way northbound and Surface Artery should be made one-way southbound, and that other more modest proposals be implemented to further improve traffic flow.

During the preparation of this assessment, the two alternatives were developed further to determine feasible geometric configurations. The major features of each remained essentially the same but it was possible to "fine tune" the two alternatives. As a result, a number of options were developed related to the following:

- Handling of inbound commuter buses,
- Handling of outbound commuter buses,
- Design of South Street,
- Design of Atlantic Avenue, and
- Design of Surface Artery Southbound.

These items are discussed briefly below. The specific questions raised in the MEPA certificate regarding the China Gate really do not apply to either Alternative A or B. The basic goal of both alternatives is to create a pedestrian space in the area of the China Gate that would not be utilized for traffic. Currently, Beach Street is posted one-way westbound under the gate. For both Alternatives A and B, Beach Street would be closed entirely, the goal being to improve the quality of life in the area by eliminating through traffic. Only emergency vehicles would be allowed to pass through the China Gate and this would be accomplished with a design that would eliminate the possibility of drivers using this street. No consideration was given to any build alternative that would keep Beach Street open to through traffic.

2. Inbound Express Buses

Both Alternatives A and B were developed with the goal being to improve inbound access to the Downtown Crossing area for express buses. Several concept plans were prepared during the study to identify ways in which inbound commuter buses could be accomodated. Option 1, which would provide buses with an exclusive right-of-way along portions of Atlantic Avenue (adjacent to the Dewey Square Tower) and Summer Street (between Atlantic Avenue and Purchase Street) was prepared. On other portions of the inbound route, under this plan, buses would move with mixed traffic. The primary goal of this particular route was to provide a convenient transfer point at South Station with a stop located directly adjacent to the Dewey Square Tower on an enlarged island (widened from 6 feet to 10 feet).

Buses would travel on the west side of the island (14 foot lane) and receive signal priority through the intersection with Summer Street. A separate bus only lane would be provided on Summer Street between Dewey Square and Purchase Street and from there, buses would move in mixed traffic to the Federal and Franklin Street stops.

While Option 1 was formulated to provide good commuter bus access to the South Station area, other alternatives are also available to handle the inbound traffic. These alternative routes are indicated in Figure 16 and possible bus stop locations are indicated. Option 2 comes closest to providing the desired access to South Station since it would utilize Essex Street. While it is circuitous, the primary benefit is that it would allow buses to bypass the congested Dewey Square intersection and similarly avoid the Purchase Street/Summer Street intersection. It also provides the opportunity for bus layovers along Essex Street. Option 3 (which utilizes Lincoln Street) is considerably further from the Atlantic Avenue corridor but does provide a clear alternative for inbound vehicles. Option 4 considered the possibility of allowing South Street to continue to be used in the future, however, as a bus only lane.

Table 8 was developed to summarize the characteristics, advantages and disadvantages of each of the four alternative routes considered. The table provides a description of each route, the distance to be traveled, and provides a description of congestion points encountered in route. Travel times were estimated based on data collected on the existing roadway system.

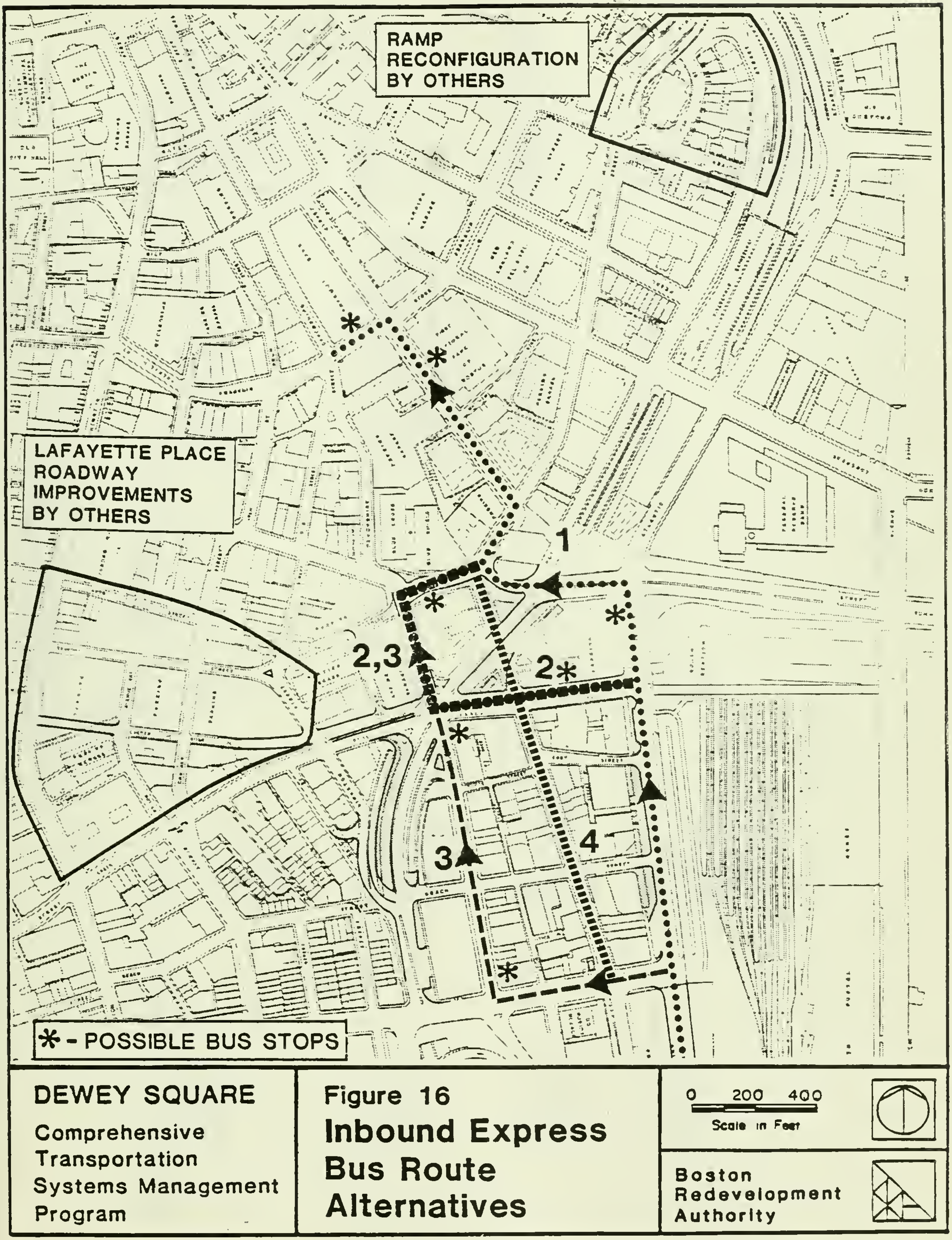
RAMP RECONFIGURATION BY OTHERS
LAFAYETTE PLACE ROADWAY IMPROVEMENTS BY OTHERS
1
2,3
2
3
4
* - POSSIBLE BUS STOPS
0 200 400
Scale in Feet

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Figure 16
Inbound Express Bus Route Alternatives

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TABLE 8
ALTERNATIVE INBOUND BUS ROUTES FROM MASSACHUSETTS TURNPIKE EXIT RAMP AT ATLANTIC AVENUE/KNEELAND STREET TO FEDERAL STREET BUS STOPS

Option Number	Route	Distance (Feet)	Congestion Points Encountered	Number of Signalized Intersections Which Must Be Passed Through Alt. A	Number of Signalized Intersections Which Must Be Passed Through Alt. B	Estimated Travel Time Alt. A	Estimated Travel Time Alt. B.	Benefits	Disadvantages
1	Atlantic Ave to Summer St to Federal St	2,500	1. Atlantic Ave/ Essex St 2. Dewey sq 3. Purchase St/ Federal St 4. High St/ Federal St (due to garage queue)	6	6 (one is ped. signal only	4 min. 44 sec.	4 min. 44 sec.	1. Serves South Station well - convenient transfer between modes 2. Signal priority at Dewey sq	1. Pedestrian interference at Dewey sq intersection 2. Difficult to enforce transit way on Summer St Confusing signal phasing. 3. No left turn from Atlantic NB to Summer St WB 4. Geometry on Atlantic Ave does not provide enough room to bypass broken down bus in exclusive lane
2	Atlantic Ave to Essex St to Summer St to High St to Federal St	2,900	1. Atlantic Ave/ Essex St 2. Essex St/Lincoln St/Surface Artery 3. Summer St/ Lincoln St (due to garage queue, illegal parking)	6	6 (two are ped. signals only)	4 min. 7 sec.	4 min. 7 sec.	1. Avoids Dewey sq yet serves South Station well 2. Utilizes new widened Essex St 3. Avoids Purchase St/Summer St intersection 4. Possibility for layovers on Essex Street 5. Creates new stop opposite 100 Summer Street	1. Requires usage of Lincoln St from Surface Artery to Summer St
3	Kneeland St to Lincoln St to Summer St to High St to Federal St	2,950	1. Essex St/Lincoln St/Surface Artery 2. Summer St/Lincoln St (due to garage queue, illegal parking)	6	6 (two are ped. signals only)	5 min. 10 sec.	5 min. 10 sec.	1. Avoids Dewey sq congestion 2. Creates new stop opposite 100 Summer St	1. Difficult turn from Kneeland St to Lincoln St 2. Does not serve South Station at all
4	Kneeland St to South St to High St to Federal St — Essex	2,350	1. Essex St/ South St 2. South St/ Surface Artery 3. High St/Summer St/South St 4. High St/Federal St (due to garage queues)	5	5 (one would be ped. signal only)	3 min. 39 sec.	3 min. 39 sec.	1. Avoids Dewey sq congestion	1. No benefits to pedestrian flows 2. Recreates a signalized intersection at Surface Artery 3. Complicates signal at Summer St/High St 4. Eliminates the possibility of creating a development parcel 5. Does not serve Dewey sq 6. Creates potential route for autos/conflicts created

— outbound via Essex St.

The results presented in the Table indicate Option 1, while the second shortest route has an average travel time from Kneeland Street to the First National Bank of more than one minute longer than Options 2 or 4. Currently, along the existing Summer Street route buses require approximately 3.5 minutes to travel the route between Kneeland Street and the First National Bank. The reason Option 1 fares as poorly as it does is related to the congestion and pedestrian interference at Dewey Square.

Option 2 is approximately 30 seconds longer than the existing route and its key benefits are that it utilizes Essex Street to avoid Atlantic Avenue and Summer Street congestion. It does require dependence on Lincoln Street between Summer Street and Essex Street, a location which currently experiences illegal parking that reduces the width of the travelway to 1 or 2 lanes.

Option 3 was found to be the longest (time) route and while it avoids Dewey Square congestion, it does not serve South Station well at all.

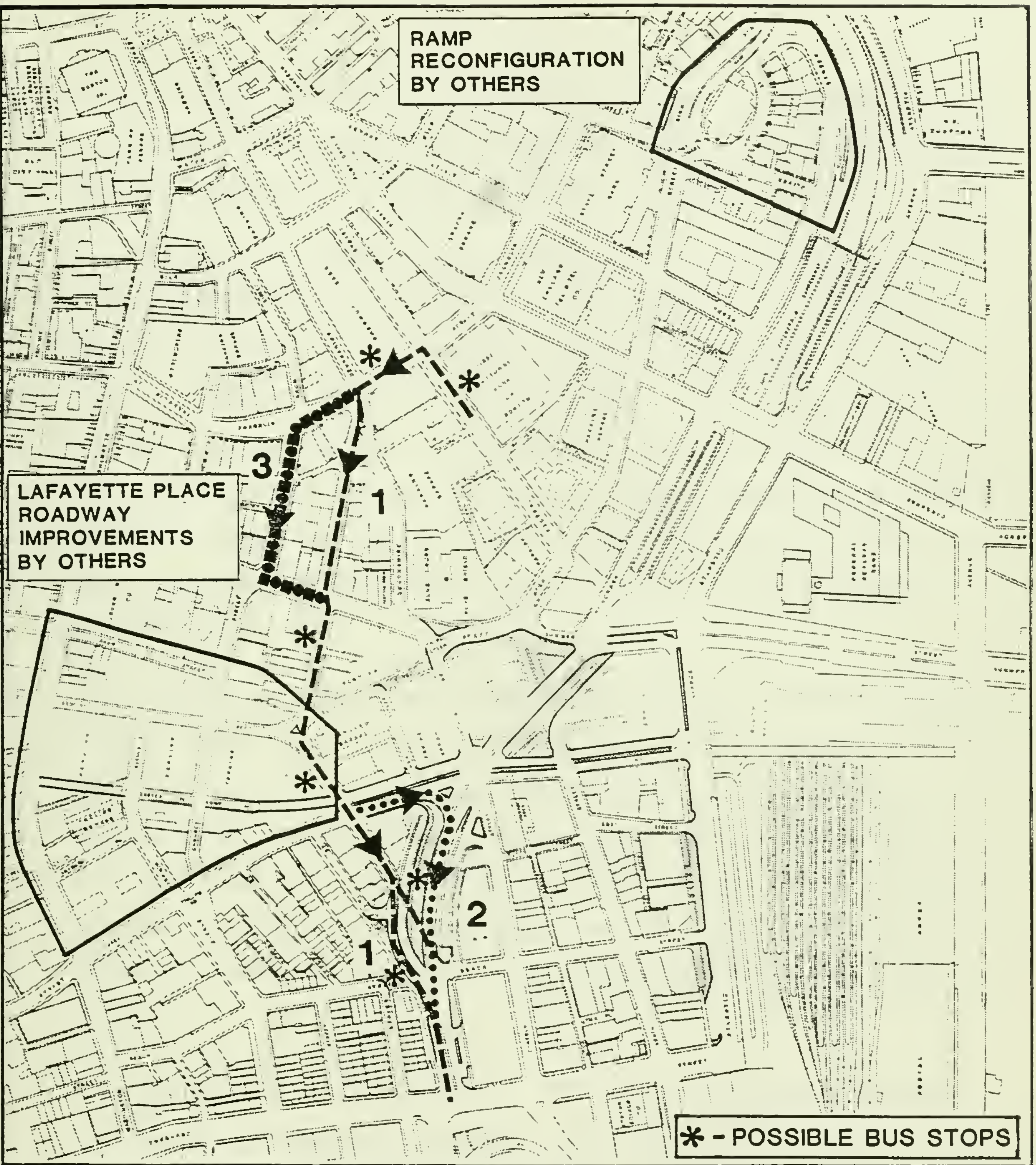
While it was considered, it was concluded that Option 4 is undesirable because it has a number of negative impacts on other major project goals. Primarily, it creates another signalized intersection on the Surface Artery and complicates the design of the High Street/Summer Street intersection. Pedestrian improvements would be similarly negatively affected by this change. It also

eliminates the possibility of a development parcel along the west side of Surface Artery. For these reasons, it was not studied further.

Because selection of one of the options does not rule out implementation of one of the others, they are all considered feasible. Several meetings were held with MBTA operations and planning personnel to discuss the alternatives and to identify other issues not previously considered. Discussions particularly centered around the location of specific bus stops and the ability of the T to accomodate its current ridership patterns. After a thorough review of the alternatives, it was the general consensus that Option 2 which utilizes Atlantic Avenue, Essex Street and Lincoln Street to reach the main bus stops was the preferred alternative route. Key reasons were that it would allow the MBTA to essentially maintain their existing stops while at the same time avoiding the two most congested intersections in the area. There was also a major concern about the provision of only a 14-foot wide bus-only lane on Atlantic Avenue. It serves South Station well and offers a reasonable travel path.

3. Outbound Express Buses

A preferred alternative was developed for accommodating outbound express buses from the Federal Street and Franklin Street bus stops. It is shown as Route 1 on Figure 17. As shown, buses would travel via Otis Street to Kingston Street to a new exclusive busway


RAMP RECONFIGURATION BY OTHERS
LAFAYETTE PLACE ROADWAY IMPROVEMENTS BY OTHERS
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2
1
* - POSSIBLE BUS STOPS

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Figure 17
Outbound Express Bus Routes Alternatives

0 200 400
Scale In Feet

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leading to Surface Artery. The benefit of this alternative is that it removes the buses from the congested Summer Street and Purchase Street intersections by shifting them to the west.

Within the design of this alternative, two sub-options were also considered and are shown as Routes 2 and 3 on the figure. Route 2 would provide the connection from Essex Street by moving buses with mixed traffic to Surface Artery. While it parallels the preferred route, its key disadvantage is that it requires buses to pass through the Essex Street/Surface Artery/Lincoln Street intersection. Operations at this location are expected to be poor and buses would likely experience longer delays and more difficult geometry there.

The designation of the portion identified as Route 3 reflects today's current travel route. The primary difficulty with this option is the right turn from Summer Street to Kingston Street. Because of the very tight geometry at this location, it would be quite difficult for a bus to negotiate this turn. Route 1, which utilizes Otis Street, was identified as the desirable alternative because it does not face the difficult geometry presented under Route 2.

In the area of Beach Street, several options for making the connection between Kingston Street and Surface Artery were considered. Among the options was a bus flyover ramp which would cross over the Beach Street off-ramp. Because of a relatively poor geometric configuration, this alternative was not viewed as favorably as the surface configuration.

The figure indicates possible bus stop locations with the key benefit being the elimination of the stop at the corner of Surface Artery and Kneeland Street. Because buses must use the curb lane for pick-up/discharge, a conflict between buses and right turning vehicles is created. Relocating the stop to the new busway as indicated will considerably reduce auto/bus conflicts and will also help to eliminate this source of delay.

Another benefit to Alternative 1 is that the surface option makes it possible to give buses priority at the Surface Artery/Beach Street intersection. Because of the difficulties expected under the other alternatives, it appears that Route 1 clearly meets the needs of providing excellent service for express buses leaving Downtown Crossing.

4. Design of South Street

Initially, it was intended that South Street would be designated as a one-way southbound street as part of a one-way couplet arrangement. It was originally planned that the four parallel one-way streets would alternate by direction with Atlantic Avenue northbound, South Street southbound, Lincoln Street northbound and Surface Artery southbound. As a result of the analysis of traffic volumes, it was found that, under the two future alternatives, South Street would carry a very light traffic burden.

Both alternatives propose closing South Street to through traffic, making it more difficult to access. Because of the reconfiguration of the northbound Central Artery on-ramp, South

Street would lead directly to this ramp if it remained one-way northbound. If it was reversed, it would only function as a service oriented street to adjacent land uses. It would most likely not carry a significant amount of regional or commuter traffic. Simply based on the accessibility it creates, it would be desirable to maintain South Street as a one-way northbound street under either Alternative A or B. The final disposition of South Street will not significantly affect either proposal.

5. Design of Atlantic Avenue

It was originally intended that Atlantic Avenue would be a one-way northbound street along its entire length. As part of this improvement, it would be desirable and highly beneficial to reconfigure the existing truck docks along the west side of the street to improve traffic flow and safety. Changes are already taking place with the owner of the block south of East Street planning to eliminate loading docks from that building. As described previously in this section, it was also desired to provide a separate express bus only lane adjacent to the Dewey Square Tower. If this option is not selected, it would be possible to modify the plan to retain a short one-way southbound section adjacent to the Tower. This section could provide curb service to the Tower if desired. Clearly, implementation of the Express bus restriction would elimnate this opportunity.

6. Design of Surface Artery Southbound

A considerable amount of attention was paid to the design of the Surface Artery southbound because of its potential impact on the Chinatown/Replacement Pagoda Park area. Another major consideration was the reuse of the existing northbound off-ramp which feeds into Lincoln Street as part of the Depressed Central Artery proposal. This ramp would be reversed from its current design and would function as an on-ramp for southbound traffic. While this possibility is considerably beyond the time frame of the TSM project, it was necessary to accommodate this feature in the plans.

Another major consideration was the width of Surface Artery - should it be three or four lanes wide? This issue received a lot of attention and it was determined that four lanes are required at the Kneeland Street approach. Because the width of the entrance ramp to the Expressway and Turnpike is limited to three lanes, the fourth lane proposed would be reserved exclusively for right turns. This essentially matches today's condition except that the far left lane is not currently used to its capacity (due to the geometric layout on both the Surface Artery and the Expressway/Turnpike ramp). Both through and right turn movements take place out of the far right lane (even though this is reserved for right turns only) and operations are also affected by an existing bus stop along this lane. Most buses cross Kneeland Street to reach the Southeast Expressway or Turnpike and they conflict with vehicles attempting to turn right at Kneeland Street. The plan proposed for the Artery between Beach and Kneeland Streets addresses both of these problems

through realignment and relocation of the bus stop on the Artery near Kneeland Street. It should be noted that under the current plans, the bus stop would be relocated to the proposed transit way.

Between Essex Street and Beach Street, the use of signal time at the Central Artery southbound off-ramp and transit way and traffic volumes on the Surface Artery requires that a minimum of three southbound lanes be provided in this block. However, providing four lanes through this section is strongly recommended for many reasons. This recommendation is related to parking, bus priority, potential work on the Central Artery, and the overall opportunity for controlling vehicles entering the Surface Artery block between Beach and Kneeland Streets. The following is an explanation of the benefits to be gained with respect to each.

- Parking - With development of a playground along the westerly side of the Artery and current demand for parking in the Chinatown area, the construction of a four lane cross-section would provide adequate width for a parking lane adjacent to the playground. While providing parking through much of the day and during off-peak periods, this lane could be used as a travel lane during the evening peak hour. This is a general condition found to exist (although unmetered) on the Surface Artery between Beach and Kneeland Streets where the four lane section now exists.

- Bus Priority - One of the major goals of this project is the establishment of a bus priority system granting buses the

right-of-way at several intersections, an exclusive transit way leaving Essex Street and "head-of-the-line" privilege at all signals where possible. As previously noted, four lanes are a requirement on the approach to Kneeland Street. Because of volumes on Kneeland Street, the maximum amount of "green-time" which may be granted to the Surface Artery southbound is 40 percent of the cycle. This amount of time would not be sufficient for the Surface Artery at Beach Street if only three lanes are provided since between 55 and 60 percent "green-time" is required at the Beach Street intersection. This additional time necessary at Beach Street (with the three lane option) will mean that there is an interval of 15 to 20 percent of the cycle when vehicles are "queuing" or arriving but not being processed at Kneeland Street. The queue could be as many as ten vehicles in two of the lanes, equal to a length of 250-300 feet. In order to reduce overall vehicle delay in the corridor and minimize the length of this queue, the extra "green-time" at Beach Street must be given after the signals at Kneeland Street turn red rather than immediately before signals at Kneeland Street turn green. This would allow development of a queue at Kneeland Street so that once the signal turns green, the volumes could be processed efficiently. With this queue, buses would enter the block between Beach and Kneeland Streets a considerable distance from the head-of-the-line. Under the four lane option, the amount of "green-time" would be balanced at both intersections since less "green-time" would be needed at Beach Street, insuring that virtually no queue would be

present at Kneeland Street and hence buses would be given head-of-the line privileges. This would improve flow for vehicles as well since a "progressive" phasing pattern could be developed between intersections. A second advantage to a four lane section is that buses would be given a considerably increased "green-time" at Beach Street, further reducing their delays.

- Potential Work On The Central Artery - With either depression of the Central Artery or a rehabilitation project in the South Station Tunnel, the Surface Artery becomes an extremely important link in the City's transportation system. With implementation of the Dewey Square TSM Plan, the Surface Artery is one of only two north-south surface roadways leaving the City between the Fort Point Channel and Tremont Street. The other roadway, Harrison Avenue, is narrow and would experience considerable congestion due to left turns to, and use of, Kneeland Street which is necessary to reach the Expressway and Turnpike. Even if traffic on the Surface Artery reached the saturation level at Kneeland Street, the fourth lane north of Beach Street would increase the storage capacity of the roadway and, in that manner aid in the reduction of impacts within Dewey Square.

- Control of Vehicle Movement - Because a four lane cross-section reduces the amount of "green-time" necessary at Beach Street for general traffic, there would be additional flexibility in

controlling overall progression of movement on the Surface Artery (this has been generally described in the section on Bus Priority).

- Other Concerns - In addition to these four major subject areas, several other less obvious reasons support the four lane section. During periods of and just following heavy snow fall, a travel lane is often lost for varying periods of time. The impact of this lost lane would be minimized if the reduction were to three lanes rather than two. The same is also true during intervals of utility work or fire fighting conditions. It is also considered desirable if the downstream constraints mentioned previously did in fact come to be or if traffic volumes increase at a higher than projected rate.

  Many of the same arguments may be made for providing the four lane cross-section between Summer and Essex Streets. This is also recommended but more on the basis of additional queuing areas which will reduce the potential for traffic to disrupt flow within Dewey Square itself.

In summary, the use of a four-lane cross-section is a minimum requirement on the Surface Artery from Beach Street to Kneeland Street and a strongly recommended feature from Summer Street to Beach Street. The change to the proposed transit way from a structured crossing of the Central Artery's Beach Street off-ramp to a point south of the off-ramp (closer to Beach Street) has substantially increased land available for development of relocated

Pagoda Park. The provision of four lanes on the adjacent Surface Artery (total width increase in change from three to four lanes is 11-12 feet) does not significantly disrupt the available area.

FUTURE TRAFFIC VOLUMES

A. PEAK HOUR TRAFFIC VOLUMES

Peak Hour traffic data used to evaluate the proposed changes to the program area roadway system was initially developed in 1982 by SG Associates, Inc., under contract to the Boston Redevelopment Authority (BRA). SG's work concentrated on reviewing all available traffic data and developing traffic volume flow networks which represent existing and future conditions. This work was summarized in a series of memoranda to the BRA. During the Dewey Square TSM project, additional review of available traffic data was conducted along with an updating of previous work. The following section of this report briefly summarizes the results of this phase of the project.

B. INITIAL DEVELOPMENT OF EXISTING TRAFFIC VOLUMES

Review of available data identified five sources of traffic volume data in the South Station area. Of the five sources identified, only two contained complete traffic networks. The sources, the Boston Redevelopment Authority (1980) and the Central Transportation Planning Staff (CTPS) South Station Access Study (March, 1979) were both based on City of Boston traffic counts taken between 1978 and 1980.

The CTPS data included both AM (8:00-9:00 AM) and PM (5:00-6:00 PM) peak period volumes while the BRA volumes present the PM peak only. Comparisons between the available CTPS and BRA PM Peak

Hour data by SG Associates revealed several major discrepancies between the two sets of volumes. The differences were primarily in the amount of northbound traffic present on the surface streets (Atlantic Avenue, South Street, Lincoln Street, Surface Artery) which is likely attributable to conditions on the Central Artery. One possible reason for this fact is that when severe congestion and backups occur on the northbound Central Artery/Southeast Expressway, drivers may choose alternate routes to bypass those sections which are heavily congested. The conclusion reached by SG was that the CTPS volumes were considerably higher than the BRA volumes on the surface streets, indicating that heavy congestion conditions were indicative of the CTPS volumes. This fact was confirmed with several supplemental traffic counts. Other smaller discrepancies were identified, studied and corrected. The result of SG's review of available data was that the BRA PM peak hour volume network should be used for design and analysis since it represents a reasonable design condition (i.e., no severe congestion in the Dewey Square Tunnel or on the Central Artery). The CTPS AM network was recommended to be used for design volumes during the morning peak period.

During the Dewey Square TSM project, the recommended base networks were also reviewed and revised. Corrections were made to balance traffic flow into and out of the program area as necessary and additional data was observed and recorded. A further set of adjustments was made once the new Atlantic Avenue off-ramp was open and additional traffic counts were made. The result of this phase

of the project was the final development of two complete flow networks for each of the three conditions, one for AM and the other for PM peak hour conditions. In addition to the base condition, networks were developed for the 1987 No Build, Alternative A and Alternative B conditions. These flow networks served as the basis for analysis and comparison between Alternatives A, B and the No Build.

C. INITIAL ASSUMPTIONS - ALTERNATIVES A & B

Based on previous concept plans prepared for the Dewey Square area by the BRA, SG Associates reassigned existing traffic on the revised surface street system. They considered two options: Option 1 (or Alternative A) involved a series of changes primarily in the South Station Area while Option 2 (or Alternative B) features additional changes including reversing the direction of High Street to one-way northbound between Summer and Pearl Streets. The assumptions made by SG Associates in developing the traffic flow networks for the two analysis conditions are summarized below:

1. Alternative A

- Surface Artery one-way southbound between Summer and Kneeland Streets.
- Atlantic Avenue one-way northbound from Kneeland Street to High Street.
- Essex Street widened to accommodate two-way traffic.

- Central Artery northbound on ramp from Surface Artery relocated to South Street.
- South Street becomes one-way southbound between Summer Street and Kneeland Street.
- The existing turnpike off-ramp at the southern end of South Street reversed to become an on-ramp.
- Beach, Kingston and Edinboro Streets are closed to through traffic in the Chinatown area.
- Bedford Street is closed between Lincoln and Columbia Streets.
- Summer Street eastbound between High Street and Surface Artery remains open.

2. Alternative B

In addition to the assumed changes listed above, when traffic volumes were initially developed, Alternative B assumed that High Street is reversed from its current one-way southbound direction to one-way northbound between Summer and Pearl Streets. Also as a result of this change, Summer Street would become one-way eastbound between Lincoln and High Streets and one-way westbound between Lincoln and Otis Streets. South Street would also be closed between Summer Street and the Surface Artery, adding land to an adjacent development parcel or creating additional pedestrian space.

Based on these assumed changes, a traffic reassignment procedure was carried out by SG Associates. This type of procedure generally involves a comparison between existing and future street networks to identify new traffic patterns which will be created under the new configuration. In the case of both Alternatives A and B, all northbound traffic would be accommodated by Atlantic Avenue and Lincoln Street while Surface Artery and South Street offer the two southbound alternatives. Widened Essex Street parallels Summer Street and as a result, reduces the left turn demand from Summer Street eastbound to Atlantic Avenue northbound.

D. REFINEMENT OF PREVIOUSLY DEVELOPED PEAK HOUR VOLUMES

Along with the development of the Dewey Square TSM project, the initial concepts were further refined on a pair of 1"=40' scale plans. As a result of several additional changes proposed for the street system, it was necessary to update the flow networks to reflect the latest roadway configurations in the program area. During the development of the 40 scale plans, several changes were made to the initial roadway network plans including the following:

- Elimination of the proposed South Street on-ramp to the Massachusetts Turnpike.

- Closing the short eastbound Summer Street connection between High and Purchase Streets.

- Implementation by 1987 of the South Station Transportation Center (SSTC) Phase 1 ramping system which provides direct bus ramp connections between Kneeland Street, the Massachusetts Turnpike, and the Southeast Expressway. This will reduce existing commuter bus demands on Atlantic Avenue and place greater emphasis on Kneeland Street.
- Closing the short southbound segment of South Street between Surface Artery and Essex Street.
- Prohibition of left turns by automobiles from Atlantic Avenue northbound to Summer Street westbound.
- Creation of a bus prioritization system along Atlantic Avenue and Summer Street for MBTA buses entering the program area. MBTA Buses exiting the Downtown Crossing would be relocated to Kingston Street where several options were considered for routing them to Surface Artery southbound.

E. BACKGROUND TRAFFIC

In addition to making these described changes, it was also necessary to identify the level of new or background development that will likely be in place by the 1987 horizon year. In the development of the SG traffic networks, the only new development for which additional traffic was generated and added was the Lafayette Place project adjacent to Jordan Marsh on Washington

Street. For this study, the following projects were assumed to be in place and operational in developing 1987 volumes:

- Lafayette Place
- BOSCOM Redevelopment of Commonwealth Pier 5 as a High Technology Marketing Center on Northern Avenue in South Boston.
- Rehabilitation of Building 114 at the Boston Army Base/ BMIP on Summer Street as a Garment Center/Mixed Use project.
- Continued redevelopment and expansion of the Boston Marine Industrial Park (BMIP).
- Development of Piers 1, 2 and 3 on Northern Avenue for a mixed use housing/hotel/retail development.
- Completion and full operation of the 46 story Dewey Square Office Tower (One Financial Center).
- Construction of a 500 space parking deck above the proposed South Station bus terminal.
- Miscellaneous reuse of vacant warehouse buildings on Summer and Congress Streets for various apartment and office uses.

The detailed traffic volumes which were generated and added by these projects has been described in both the Building 114 Final

Environmental Impact Report (EOEA #4427) and the Commonwealth Pier 5 Final Environmental Impact Report (EOEA #4133).

A recent study of the Downtown Crossing conducted by Skidmore, Ownings and Merrill for the BRA was reviewed in light of the fact that conceptual plans of various building opportunities in the area were developed. No additional traffic was added for any of the projects included therein, however since they represent only conceptual opportunities and there are no firm commitments on their construction at this point in time. Further, several are located on sites that serve as parking lots/garages and consequently already generate traffic. For the purposes of this analysis, the redevelopment of several City-owned parking garages for commercial/ office uses was not explicitly considered. At the time the traffic volume networks were prepared, no firm commitments on these projects had been made (Government Center, Kilby Street Garage, Fort Hill Garage).

Until recently, a 180± space parking lot was located at the southern end of Atlantic Avenue. This lot was eliminated by the construction of the new Mass. Turnpike off-ramp, however, its traffic activity was included in both the base and future traffic volume projections. By considering these volumes, the planned use of the adjacent parcel by Wang has already been taken into account in terms of traffic volumes.

F. 1987 NO BUILD VOLUMES

When the initial traffic planning work for the Dewey Square area was completed, a set of 1987 No Build networks was not created. Because of their usefulness in comparing future project impacts under Alternatives A and B with projected conditions, AM and PM No Build networks were developed as part of this project.

Because the future No Build networks should incorporate the projected roadway changes planned for the area (other than the Dewey Square TSM project), it was assumed that Essex Street would operate as a two-way street along its entire length between Chauncy Street and Atlantic Avenue. The already completed relocation of the Turnpike off-ramp from South Street to Atlantic Avenue is included. Further, the background traffic generated by the eight listed projects in the previous section were all added to develop the 1987 conditions.

No other changes are assumed for the 1987 No Build networks. This means that Surface Artery is assumed to remain two-way and South Street remains one-way northbound. Other contemplated roadway changes under the Dewey Square TSM project are not considered.

The assumptions made in regards to the South Station Transportation Center are that by 1987, the horizon year, only the Phase 1 bus ramping system will have been completed. For this study, no air rights development above the existing trackage was

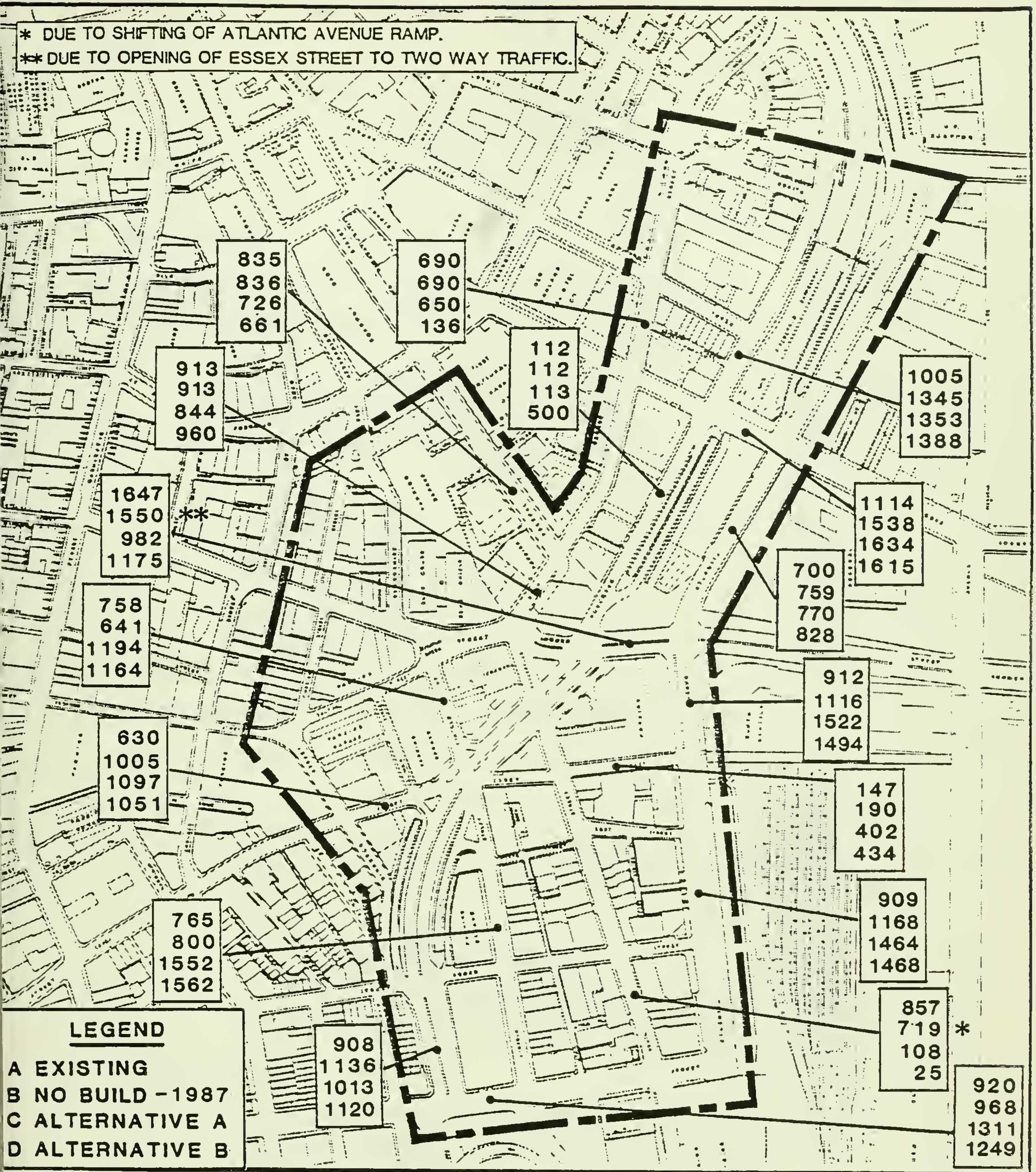
assumed to be complete and operational by 1987. In fact, the projected project completion date is beyond 1990.

G. FUTURE VOLUME PROJECTIONS

Because of the complexity of the traffic flow networks and the difficulty in presenting this data, a pair of simplified graphics were developed to present this information in an understandable manner. Figures 18 and 19 present traffic volumes on the key roadway links in the program area for the AM and PM peak hours, respectively.

A comparison of the two figures in Table 9 provides an indication of the changes that the proposed improvements will bring. It should be realized that volumes shown for Alternatives A and B include the additional traffic that will result by 1987 from background development described previously.

Overall, the implementation of either Alternatives A or B plus the addition of new background traffic will result in shifts in traffic volumes on many of the program area's streets. Data presented in Table 9 indicate changes (in comparison with existing volumes) ranging from a 97 percent decrease in traffic on South Street to an increase of 108 percent on Lincoln Street. While these changes in themselves do not present an indication of the quality of traffic flow, they do indicate the relative changes and importance of key streets. As a result of this comparison, a number of key facts were determined and are summarized below:



DEWEY SQUARE

Comprehensive
Transportation
Systems Management
Program

Figure 18

AM Peak Hour Traffic Volume Summary

0 200 400

Scale in Feet

Boston
Redevelopment
Authority

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this change. While trucks would still be required to travel adjacent to the Central Artery, the likelihood of an accident due to the geometry would be significantly reduced.

CONCLUSIONS - SUMMARY OF FINDINGS

The Dewey Square Comprehensive TSM program was developed as a means of improving transit and traffic operations at this major transportation mode in Downtown Boston. The primary project goals are to improve person movement capacity into Boston's Financial District through implementation of bus prioritizaton strategies while at the same time improving operating efficiency of the area's traffic control and roadway network. This document presents results of a detailed analysis of several alternative improvement plans. It includes a detailed description of existing roadway conditions, a review of existing and projected traffic volumes and an assessment of the impacts of each alternative. The findings are summarized below:

EXISTING CONDITIONS

The Dewey Square area can be characterized as having a number of deficiencies which cause congestion and safety problems and create considerable delays for motorists, transit passengers and pedestrians. These deficiencies include the following:

- Extremely close spacing between signalized intersections which, when combined with heavy peak hour traffic, leaves an inadequate area for vehicle storage and creates queuing and intersection blockages.

- Interference between curbside use (parking, loading, taxi activity, bus stops, etc.) and moving traffic.

- Use of the area's surface street system as a bypass route for traffic attempting to avoid congestion on the Central Artery.
- Heavy bus and truck volumes that are forced to compete with both local and regional traffic on area streets.
- Very heavy pedestrian volumes and a general public disregard of designated crosswalks and signal phases.
- A prohibition against trucks carrying dangerous cargos throughout the Central Artery's Dewey Square Tunnel requires they be accommodated on several local streets.

The problems listed above result in a very inefficient roadway system which is particularly apparent during the peak commuter periods.

FUTURE IMPROVEMENTS

This study identified two improvement options to meet the goals of the Study. Alternative A provides for an improved roadway configuration which generally includes the following:

Alternative A

- Designation of Atlantic Avenue and Lincoln Streets as one-way northbound while South Street and Purchase Street would become one-way southbound. All southbound traffic would be eliminated on Atlantic Avenue and all northbound traffic on Surface Artery would similarly be eliminated. High Street would remain one-way northbound as it is today.

- A total of four options were identified to accommodate the MBTA's inbound Express bus service which travels along the Massachusetts Turnpike from the western suburbs. These options apply to both Alternatives A and B equally. One route studied would require inbound buses to travel along Atlantic Avenue in mixed traffic to Essex Street and then on an exclusive busway through the Summer Street intersection to High Street where the signalization pattern would give buses priority into the Financial District. The second option studied would utilize portions of Atlantic Avenue, Essex Street and Lincoln Street to bypass Dewey Square and reach the major Downtown stops on Federal and Franklin Streets. Two other alternatives were considered - one that would utilize Lincoln Street entirely and the other that would involve reopening South Street to buses. Based on the numerous meetings and discussions with MBTA officials, Option 2 which utilizes Atlantic Avenue, Essex Street, Lincoln Street, High Street and Federal Street for inbound buses was selected as the prefered alternative. This decision was based on a number of factors including distance, travel time and congestion.

- Two options were studied for outbound buses and both utilized an exclusive busway along Kingston Street. One considered a structure to cross over the Beach Street southbound off-ramp, the other (the preferred alternative) features a surface route that includes construction of a busway around the west side of the Beach Street off-ramp from the Central Artery. To exit

the area under the prefered alternative, outbound buses would utilize Kingston Street, a new exclusive busway in the vicinity of the China Gate at Beach Street and a portion of the Surface Artery to reach the Massachusetts Turnpike. This route would allow buses to bypass most of the Surface Artery and avoid considerable traffic congestion.

- Under Alternative A, several street links would be closed or eliminated to reduce conflicts and resultant congestion. Specifically, South Street northbound would be closed between Essex Street and Summer Street, as would Summer Street eastbound between Purchase Street and High Street. With Alternative A, High Street would remain one-way southbound and the southbound link between High Street and Surface Artery adjacent to the South Station Cinema would remain. Other proposed closings include Bedford Street between Lincoln and Columbia Streets and the closing of Beach, Edinboro and Kingston Streets to through traffic in Chinatown.

- Both alternatives were developed to accommodate a future southbound on-ramp to the Central Artery at the location of the now closed Lincoln Street northbound exit.

Alternative B

This concept primarily differs in that High Street would be reversed to run in a one-way northbound direction. This change further simplifies operations along Surface Artery, Summer Street

TABLE 16

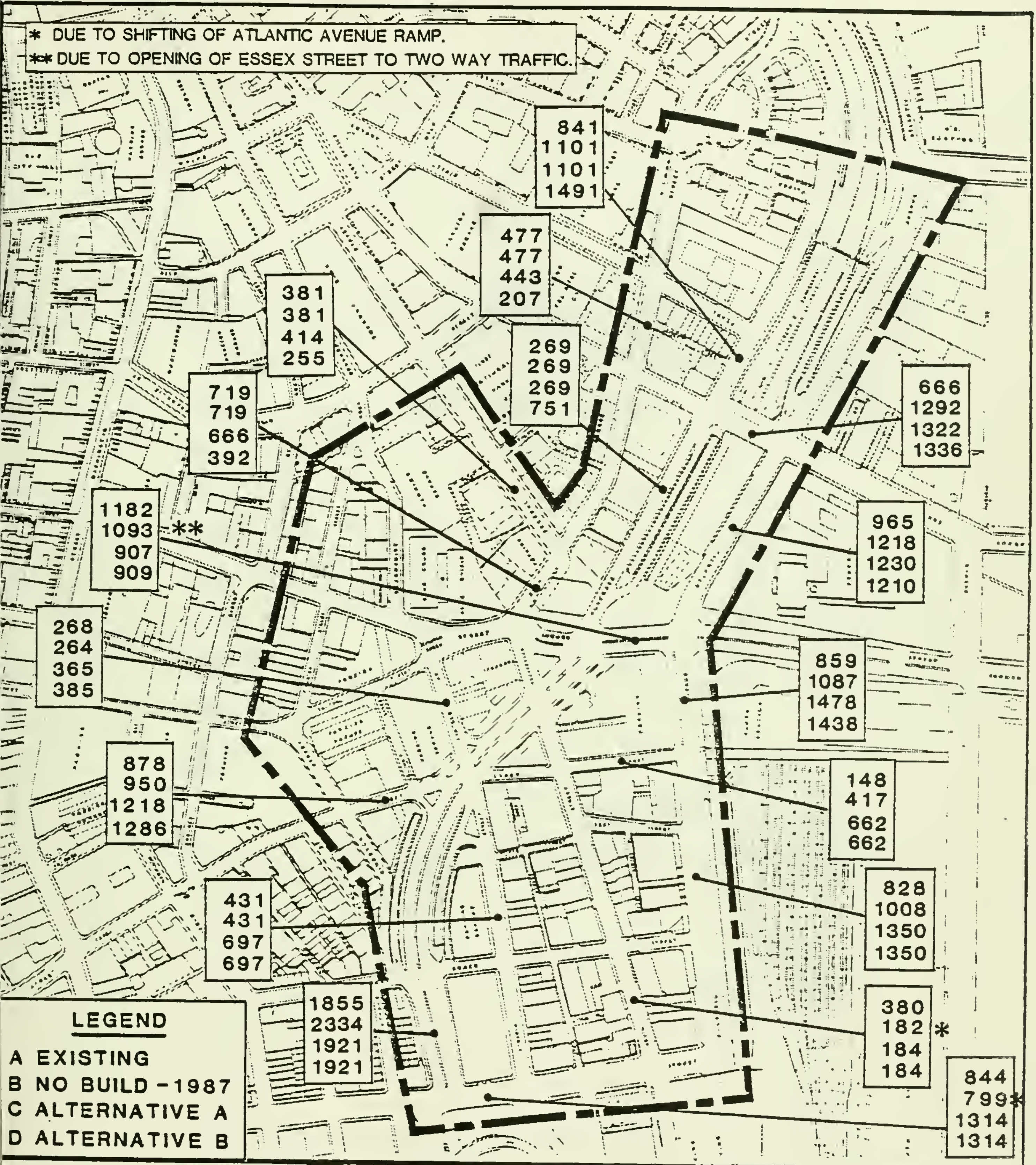
SUMMARY MATRIX OF ADVANTAGES AND DISAD

Impact Category	No Build		Concept A	
	Advantages	Disadvantages	Advantages	Disadv
Roadway Configuration/ Compatibility with Area Land Use	o No Expenditure of funds for design and construction	o Inefficiency of existing system will remain. No accomodation of increases in traffic o Continued impact on Chinatown o Conditions will worsen as development occurs in Downtown and South Boston	o Allows intersections to be simplified by eliminating northbound Surface Artery o Reduces conflicts at seven intersections o Eliminates through traffic from Chinatown o Improves Church Green (Closes Bedford Street) o Increases spacing between intersections o Allows flexibility with South Street o Compatible with South Station rehabilitation project	o Cont betw Surf o Inca relo as p Plac o No p devel Summe
Traffic Improvements	o None	o Does not allow the retention of the Lincoln St southbound on-ramp with Depressed Artery o Peak period congestion will continue, resulting in congestion and overlapping queues between intersections o Nine intersections at LOS "D" or below	o Project responds to changing traffic patterns o Access to Summer St from Purchase St is continued o Traffic will shift from Summer St to Essex St, reducing conflicts at Dewey Sq o Improves Surface Artery intersections, particularly at Beach St and Essex St o Reduces street blockages due to truck loading at Teradyne, on Atlantic Ave o Eliminates through traffic from Chinatown o Improves coordination between signals yielding better progression, shorter queues o Widened Essex Street	o Compl Summe o Increa Lincol o Four r availa future o Nine i or bel o Dewey bottle
Pedestrians	o None	o Continued long and difficult pedestrian crossings o No improvements at Dewey Sq	o Some improvement at High/ Summer/Purchase Streets o Pedestrian access to Chinatown, Church Green improved by street closing o Dewey Sq crossings simplified by signal phasing changes.	o South S creatin
Dangerous Materials/	o None	o Trucks would continue to use High Street o Continued wrong way fire vehicle flow on Essex St	o No change from existing o Fire access to Essex St improved by two-way flow o Access to Chinatown provided	o Without would s
Bus Flow	o Current use of South Street for inbound buses is shortest, most direct route	o Reliability of outbound buses will likely worsen with traffic growth o Extreme congestion occurs at Summer/Surface Artery o Conflicts at Kneeland/Surface Surface Artery continue	o Several options available for inbound buses o Preferred alternative utilizes Essex, Lincoln Streets and Atlantic Ave for inbound route o Outbound buses significantly improved o Buses move with coordinated signals in mixed traffic	o May not an exclu length c o Existing ation ne way flow

Concept B	
	Disadvantages
rticu- Summer/ Central rom t project n St n at on	o Takes away a southbound arterial (High Street), forcing traffic to use either Franklin or Purchase Streets
g rtery k tic Ave sec- St, nal nation ing in ficantly at Bank , St mmer/ n	o Reduces number of avialble northbound routes to 2, Atlantic Ave, Franklin St o Eleven intersections at LOS "D" or below o Dewey Sq continues to be a bottleneck o Truck exiting from Hawley St to Summer St prevented - alternate routes must be used
, ing ved by	o Without ramp relocation, a difficult turn would result at corner of Oliver/Purchase o Access to a fire on High St more difficult with reversal
inbound s Essex, ve for mproved gnals at r St)	o Doesn't provide full exclusive bus lanes

TABLE 16
SUMMARY MATRIX OF ADVANTAGES AND DISADVANTAGES BY ALTERNATIVE

	No Build		Concept A		
Impact Category	Advantages	Disadvantages	Advantages	Disadvantages	Advantages
Roadway Configuration/ Compatibility with Area Land Use	o No Expenditure of funds for design and construction	o Inefficiency of existing system will remain. No accomodation of increases in traffic o Continued impact on Chinatown o Conditions will worsen as development occurs in Downtown and South Boston	o Allows intersections to be simplified by eliminating northbound Surface Artery o Reduces conflicts at seven intersections o Eliminates through traffic from Chinatown o Improves Church Green (Closes Bedford Street) o Increases spacing between intersections o Allows flexibility with South Street o Compatible with South Station rehabilitation project	o Continues use of South St between Summer St and Surface Artery o Incompatible with proposed relocation of High St ramp as part of International Place project o No possibility of a development parcel at Summer/High and South Sts	o Simplifies intersections, larly along Surface Artery High Streets o Particularly compatible wi Artery depression o Eliminates through traffic Chinatown o Improves Church Green o Increases spacing between intersection o Particularly compatible wi relocation of the High Str ramp by International Plac o Allows flexibility with So o Compatible with South Stat rehabilitation project o Potential development parc High/Summer/South Intersec
Traffic Improvements	o None	o Does not allow the retention of the Lincoln St southbound on-ramp with Depressed Artery o Peak period congestion will continue, resulting in congestion and overlapping queues between intersections o Nine intersections at LOS "D" or below	o Project responds to changing traffic patterns o Access to Summer St from Purchase St is continued o Traffic will shift from Summer St to Essex St, reducing conflicts at Dewey Sq o Improves Surface Artery intersections, particularly at Beach St and Essex St o Reduces street blockages due to truck loading at Teradyne, on Atlantic Ave o Eliminates through traffic from Chinatown o Improves coordination between signals yielding better progression, shorter queues o Widened Essex Street	o Complicates intersection of Summer/High o Increases dependence on Lincoln St, Atlantic Ave o Four northbound routes available today, only two in future o Nine intersections at LOS "D" or below o Dewey Sq continues to be bottleneck	o Concept B responds to chang traffic patterns o Eliminates traffic signals High/Federal, South/Surface o Reduces blockages due to tr loading at Teradyne, on Atl o Improves Surface Artery int tions, particularly at Esse Beach St o Design of new coordinated S System relocates queuing to peripheral intersections o Significantly improved coor between signal systems resu better control of queuing o Improves progression betwee signalized intersection o Widened Essex St o Traffic will be reduced sig on High St o Parking/loading lane create Fiduciary Trust Building (B Boston) o More emphasis on Atlantic A reduced importance of Summe
Pedestrians	o None	o Continued long and difficult pedestrian crossings o No improvements at Dewey Sq	o Some improvement at High/ Summer/Purchase Streets o Pedestrian access to Chinatown, Church Green improved by street closing o Dewey Sq crossings simplified by signal phasing changes.	o South St remains open, creating additional	o Greater improvment at High/ Purchase vs. Concept A o Improved pedestrian flow to Chinatown through Church Gr
Dangerous Materials/	o None	o Trucks would continue to use High Street o Continued wrong way fire vehicle flow on Essex St	o No change from existing o Fire access to Essex St improved by two-way flow o Access to Chinatown provided	o Without ramp relocated, trucks would still use High St	o By relocating High St off-r trucks use Purchase St, rem impact from High St o Fire access to Essex St imp two way flow o Access to Chinatown provide
Bus Flow	o Current use of South Street for inbound buses is shortest, most direct route	o Reliability of outbound buses will likely worsen with traffic growth o Extreme congestion occurs at Summer/Surface Artery o Conflicts at Kneeland/Surface Surface Artery continue	o Several options available for inbound buses o Preferred alternative utilizes Essex, Lincoln Streets and Atlantic Ave for inbound route o Outbound buses significantly improved o Buses move with coordinated signals in mixed traffic	o May not be possible to provide an exclusive bus lane the full length of Atlantic Ave o Existing contra flow configuration necessary due to two-way flow on High Street	o Several options available f buses o Preferred alternative utili Lincoln Streets and Atlanti inbound route o Outbound buses significantl by Kingston Street bypass o Buses move with coordinated in mixed traffic o New stops created on Summer



DEWEY SQUARE
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Figure 19
PM Peak Hour Traffic Volume Summary

0 200 400
Scale in Feet

Boston
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TABLE 9
COMPARISON OF PEAK HOUR TRAFFIC VOLUMES BY LOCATION AND ALTERNATIVE

	AM Peak Hour				
Location	Existing Volume	Alt. A Volume	% Change Over Existing	Alt. B Volume	% Change Over Existing
Atlantic Ave. south of Summer St.	912	1,382	+51.5	1,354	+48.5
South Street at Kneeland St.	792	108	-86.4	25	-96.8
Lincoln St. at Beach St.	765	1,552	+103.7	1,562	+104.2
Surface Artery at Kneeland St.	908	949	+4.5	1,056	+16.3
Essex St. at Columbia St.	630	1,097	+74.1	1,051	+66.8
Lincoln St. at Bedford St.	758	1,194	+57.5	1,764	+132.7
Summer St. west of Atlantic Ave.	1,647	982	-40.4	1,175	-28.7
High St. at Congress St.	690	650	-5.8	136	-80.3

	PM Peak Hour				
Location	Existing Volume	Alt. A Volume	% Change Over Existing	Alt. B Volume	% Change Over Existing
Atlantic Ave. south of Summer St.	859	1,228	+43.0	1,188	+38.3
South Street at Kneeland St.	380	184	-51.6	184	-51.6
Lincoln St. at Beach St.	431	697	+61.7	697	+61.7
Surface Artery at Kneeland St.	1,855	1,705	-8.1	1,705	-8.1
Essex St. at Columbia St.	878	1,218	+38.7	1,286	+46.5
Lincoln St. at Bedford St.	268	365	+36.2	385	+43.7
Summer St. west of Atlantic Ave.	1,182	767	-35.1	769	-34.9
High St. at Congress St.	477	443	-7.1	207	-56.6

- Overall traffic increases on Essex Street and Atlantic Avenue at Dewey Square will be significant for all future alternatives. This is primarily a result of several factors: 1) the relocation of the Turnpike off-ramp, 2) the diminished importance of South Street, 3) background growth and 4) implementation of two-way traffic on an improved Essex Street.

- Traffic on both South and Summer Streets will be slightly reduced under the future alternatives. A small change (100-150 vph) will result from the construction of two-way Essex Street while larger changes will occur with the implementation of Alternatives A or B. South Street would not carry through traffic, resulting in larger decreases (600± during AM peak).

- The portion of Lincoln Street between Surface Artery and Summer Street will experience large increases in traffic under Alternatives A and B, particularly during the AM peak period. This is primarily due to the elimination of the South Street link between High and Essex Streets and the elimination of the northbound side of the Surface Artery. This segment becomes a key link between the South Station area, the Financial District and the Downtown Crossing.

- Traffic on High Street would drop considerably under Alternative B which reverses the direction of traffic flow. Southbound High Street traffic would shift to parallel routes,

primarily Purchase Street which experiences a significant increase in flow between Congress Street and the Surface Artery.

- Volumes will increase on Kneeland Street primarily due to the elimination of the northbound Surface Artery. This change forces all northbound traffic to Lincoln Street or Atlantic Avenue.

Total traffic volumes carried by Surface Artery at Kneeland Street will only experience a moderate change (400± vph) as a result of this project; however, the directional distribution of traffic flow will change considerably since northbound traffic on Surface Artery will be eliminated under both future build alternatives. Without the project, volumes on Surface Artery will be greater than if either Alternative A or B is built, primarily due to traffic growth.

ANALYSIS OF ALTERNATIVES

The previous chapters of this report have described the existing physical and operating conditions on area roadways. It also describes traffic growth and changes related to other projects expected to occur both within and outside the study area. In this section, the impact of the Dewey Square TSM project on traffic operations on the roadways in the vicinity of the site is analyzed. Included in the analysis are level of service calculations and an analysis of traffic signal operations including the effects of coordination, band widths and queuing.

A. SYSTEM ANALYSIS/DEFICIENCY DELINEATION

Measuring traffic volumes on area roadways indicate the importance of these streets but gives little indication of the quality of traffic flow. To measure quality of flow, roadway capacity was analyzed with respect to four conditions for both peak periods: Base, 1987 No Build, 1987 Build Alternative A and 1987 Build Alternative B. The subsequent analysis provides a valid indication of how well the roadway system will serve the travel demands placed upon it in the immediate future.

1. Traffic Performance Measures

"Level of Service" is a term which defines the different operating conditions which occur on a roadway or intersection when accommodating various traffic volumes. It is a qualitative measure

of the effect of a number of operational factors including speed, travel delay, freedom to maneuver and safety. In the application of a level of service to a roadway or intersection, an index to the operational qualities of the section is presented.

In practice, any roadway may operate at a wide range of levels of service, depending on the time of day, day of week or period of year. Level of Service "C", a condition of stable flow, is generally considered desirable for peak or design traffic flow in urban areas. Level of Service "A" is the optimal condition of free flow where roadway operating conditions are at their best. Level of Service "E", on the other hand, represents an unstable flow condition where excessive congestion and delays are prevalent. It is often necessary to design for LOS "D" conditions in urban environments.

Efficiency of vehicular movement on urban roadways is directly affected by the capacity of associated intersections as well as by the number of curb cuts and driveway openings along the roadway. Capacity calculations can be conducted for both roadway links and intersections. In the case of the study area where intersection spacing is short and operations are controlled by traffic and pedestrian signals, the intersection operations generally define the LOS to be provided.

The intersections within the Dewey Square Study Area experience periods of traffic congestion, particularly during the peak hours when the area's office working population routinely arrive and

depart from work. This activity, combined with heavy pedestrian demand and regional commuter traffic, leads to peak period congestion and results in delays to drivers and vehicle queuing. To quantify the nature of these operations, LOS analyses were conducted for all four conditions.

2. Signalized Intersections

Levels of service for the signalized intersections in the Dewey Square area were determined by using Critical Movement Analysis. This procedure relates the capacity of an intersection to the lane utilization on each approach. The critical lane volume (CLV) is defined as the highest total of equivalent through traffic on an approach plus its opposing left-turn movement, assuming efficient multi-phase signal operation. The CLV for each phase is summed and the total used as an indication of level of service. Planning application criteria were used as a basis for determining the LOS1/. Table 10 summarizes the relationship between level of service, signal phasing, critical lane volume and delay.

Table 11 summarizes the cases and special considerations given to each intersection regarding reductions in the CLV summation. As can be seen, the reduction assumed for the criteria generally ranges from 0 to 30 percent. A reduction in the criteria of 30 percent means that pedestrians would use 30 percent of the green time at a

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1/ "Transportation Research Circular Number 212, Interim Materials on Highway Capacity," Transportation Research Board, Washington, D.C., January, 1980.

TABLE 10
LEVEL OF SERVICE CRITERIA FOR SIGNALIZED INTERSECTIONS[1]

	Planning Criteria				
	Maximum Sum of CLV[2]			Expected Operating Parameters	
Level of Service (LOS)	Two Phase	Three Phase	Four or More Phases	Typical V/C Ratio[3]	Delayed Range (Seconds/ Vehicle)[4]
A	900	855	825	0-0.60	0-16.0
B	1,050	1,000	965	0.61-0.70	16.1-22.0
C	1,200	1,140	1,100	0.71-0.80	22.1-28.0
D	1,350	1,275	1,225	0.81-0.90	28.1-35.0
E	1,500	1,425	1,375	0.91-1.00	35.1-40.0
F	-- Not Applicable --			1.00 or greater	40.1 or greater

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[1] Source: "Transportation Research Circular Number 212. Interim Materials on Highway Capacity," Transportation Research Board, Washington, D.C., January, 1980.

[2] CLV - Critical Lane Volume.

[3] V/C - Volume/Capacity Ratio.

[4] Although the delay criteria presented here have not been officially accepted, they do provide the reader with an indication of the expected delay.

TABLE 11
LEVEL OF SERVICE PEDESTRIAN REDUCTION

Intersection	Analysis Condition	Criteria (Number of Phases)	Percent Pedestrian Reduction
1. South St./Kneeland St.	Base & No Build	3	17%
	Build	2	17%
2. Kneeland St./Lincoln St./Off Ramp	All	3	17%
3. Surface Artery/Kneeland St.	Base & No Build	3	AM-24% PM-19%
	Build	2	15%
4. Beach St./Surface Artery	All	3	16%
5. Essex St./Lincoln St./Surface Artery	All	3	20%
6. Essex St./South St.	All	2	14%
7. Surface Artery/South St.	All	3	20%
8. Summer St./Atlantic Ave.	Base & No Build	3	30%
	Alternate A	4	30%
	Alternate B	3	17%
9. Purchase St./Summer St.	All	3	30%
10. Summer St./High St./South St.	All	2	30%
11. Lincoln St./Summer St.	Base, No Build Alternates A & B	3	30%
12. Otis St./Summer St.	All	2	30%
13. High St./Federal St.	All	2	30%
14. High St./Congress St.	All	2	30%
15. Congress St./Purchase St.	All	3	30%
16. Congress St./Atlantic Ave.	All	3	10%
17. Pearl St./High St.	All	2	30%
18. Essex St./Atlantic Ave.	All	2	20%
19. Purchase St./Expressway Off Ramp	All	2	30%
20. Kneeland St./Atlantic Ave.	No Build, Alternates A & B	2	0%

TABLE 13
PM PEAK HOUR
INTERSECTION LEVEL OF SERVICE SUMMARY

		1980 BASE [1,2,3]			1987 NO BUILD			1987 ALT. A			1987 ALT. B		
No.	INTERSECTION LOCATION	CLV	V/C	LOS	CLV	V/C	LOS	CLV	V/C	LOS	CLV	V/C	LOS
1.	South St./Kneeland St.	474	0.40	A	262	0.22	A	445	0.36	A	445	0.36	A
2.	Kneeland St./Lincoln St./Off Ramp	547	0.44	A	482	0.39	A	859	0.69	B	859	0.69	B
3.	Surface Artery/Kneeland St.	1,159	1.00	E	1,316	1.14	E	1,314	1.03	E	1,314	1.03	E
4.	Beach St./Surface Artery	823	0.69	B	1,050	0.88	D	636	0.53	A	636	0.53	A
5.	Essex St./Lincoln St./Surface Artery	861	0.76	C	1,001	0.88	D	884	0.78	C	914	0.80	D
6.	Essex St./South St.	484	0.37	A	No Signal			No Signal			No Signal		
7.	Surface Artery/South St.	827	0.73	C	818	0.72	C	No Signal			No Signal		
8.	Summer St./Atlantic Ave.	853	0.85	D	895	0.90	E	897	0.90	E	884	0.88	E
9.	Purchase St./Summer St.	378	0.38	A	518	0.52	A	614	0.58	A	773	0.74	C
10.	Summer St./High St./South St.	658	0.63	B	659	0.63	B	595	0.57	A	205	0.20	A
11.	Lincoln St./Summer St.	374	0.37	A	349	0.35	A	386	0.39	A	129	0.12	A
12.	Otis St./Summer St.	469	0.45	A	523	0.50	A	No Signal			No Signal		
13.	High St./Federal St.	610	0.58	A	610	0.58	A	438	0.42	A	173	0.16	A
14.	High St./Congress St.	526	0.50	A	664	0.63	B	658	0.63	B	577	0.55	A
15.	Congress St./Purchase St.	695	0.70	B	909	0.91	E	938	0.94	E	1,062	1.06	E
16.	Congress St./Atlantic Ave.	1,132	0.88	D	1,157	0.90	E	1,208	0.94	E	1,205	0.94	E
17.	Pearl St./High St.	297	0.28	A	297	0.28	A	280	0.27	A	No Signal		
18.	Essex St./Atlantic Ave.	No Signal			No Signal			648	0.54	A	638	0.53	A
19.	Purchase St./Expressway Off Ramp	388	0.37	A	388	0.37	A	408	0.39	A	646	0.61	B
20.	Kneeland St./Atlantic Ave.	No Signal			501	0.33	A	669	0.45	A	669	0.45	A

1/ CLV = Critical Lane Volume Summation
2/ V/C = Volume/Capacity Ratio
3/ LOS = Level of Service.

TABLE 12
AM PEAK HOUR
INTERSECTION LEVEL OF SERVICE SUMMARY

		1980 BASE [1,2,3]			1987 NO BUILD			1987 ALT. A			1987 ALT. B		
No.	INTERSECTION LOCATION	CLV	V/C	LOS	CLV	V/C	LOS	CLV	V/C	LOS	CLV	V/C	LOS
1.	South St./Kneeland St.	772	0.65	B	736	0.71	C	550	0.44	A	445	0.36	A
2.	Kneeland St./Lincoln St./Off Ramp	791	0.64	B	822	0.66	B	1,390	1.12	E	1,380	1.11	E
3.	Surface Artery/Kneeland St.	782	0.72	C	849	.78	C	742	0.58	A	777	0.61	B
4.	Beach St./Surface Artery	331	0.28	A	431	0.36	A	495	0.41	A	522	0.44	A
5.	Essex St./Lincoln St./Surface Artery	809	0.71	C	889	0.78	C	1,014	0.89	D	1,021	0.90	E
6.	Essex St./South St.	759	0.59	A	No Signal			No Signal			No Signal		
7.	Surface Artery/South St.	796	0.70	B	732	0.64	B	No Signal			No Signal		
8.	Summer St./Atlantic Ave.	833	0.83	D	995	1.00	E	949	0.95	E	1,035	1.03	E
9.	Purchase St./Summer St.	610	0.61	B	552	0.55	A	507	0.48	A	614	0.58	A
10.	Summer St./High St./South St.	655	0.62	B	635	0.60	B	561	0.53	A	424	0.40	A
11.	Lincoln St./Summer St.	628	0.63	B	542	0.54	A	737	0.74	C	388	0.32	A
12.	Otis St./Summer St.	309	0.29	A	297	0.28	A	No Signal			No Signal		
13.	High St./Federal St.	693	0.66	B	682	0.65	B	540	0.52	A	400	0.38	A
14.	High St./Congress St.	515	0.49	A	543	0.52	A	519	0.49	A	288	0.27	A
15.	Congress St./Purchase St.	687	0.69	B	819	0.82	D	881	0.88	D	994	1.00	E
16.	Congress St./Atlantic Ave.	1,093	0.85	D	1,118	0.87	D	1,159	0.90	B	1,181	0.92	D
17.	Pearl St./High St.	574	0.55	A	574	0.55	A	567	0.54	A	No Signal		
18.	Essex St./Atlantic Ave.	No Signal			No Signal			618	0.52	A	621	0.52	A
19.	Purchase St./Expressway Off Ramp	499	0.48	A	499	0.48	A	488	0.46	A	681	0.65	B
20.	Kneeland St./Atlantic Ave.	No Signal			818	0.55	A	943	0.63	B	940	0.63	B

1/ CLV = Critical Lane Volume Summation
2/ V/C = Volume/Capacity Ratio
3/ LOS = Level of Service.

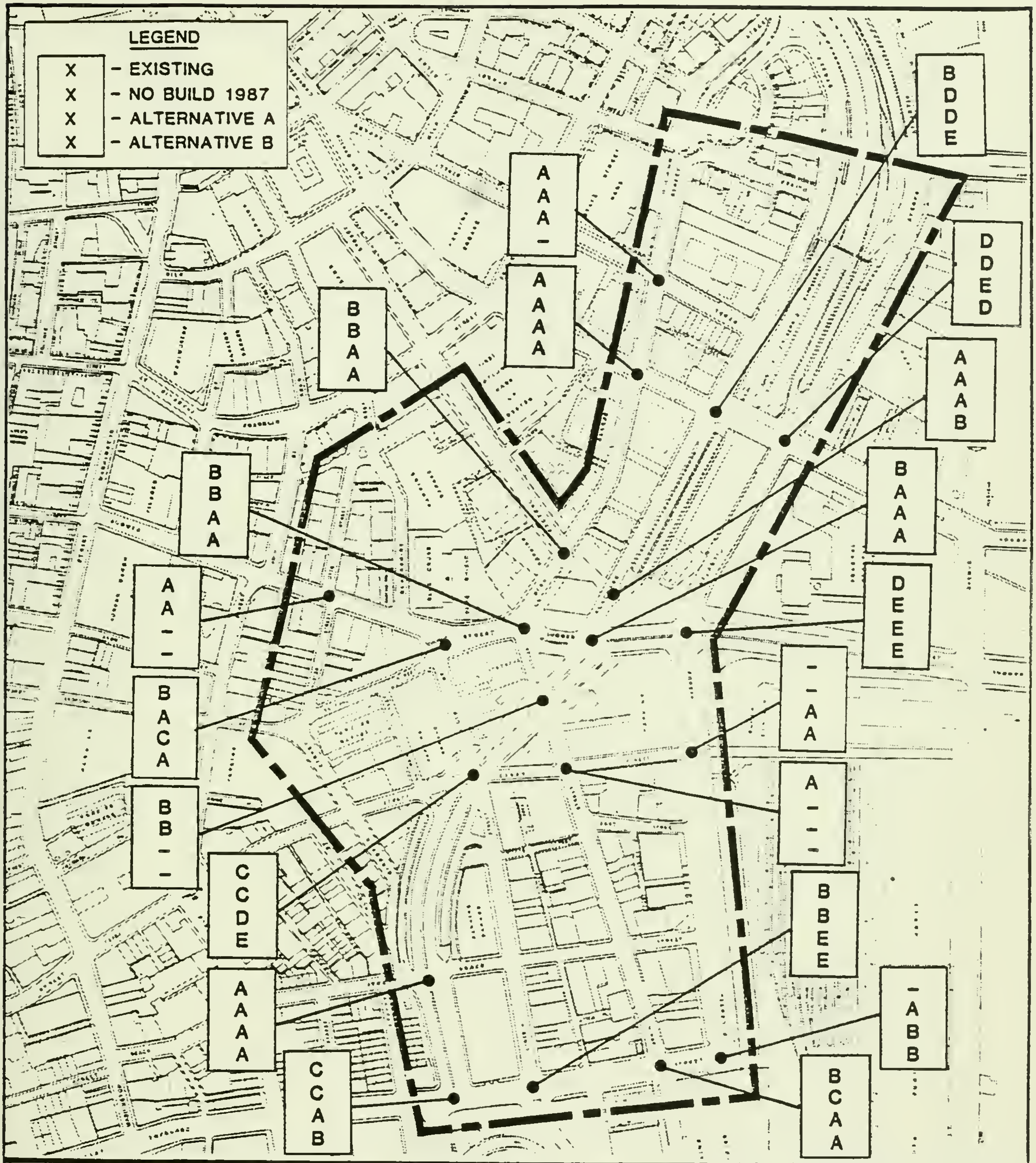

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Figure 20
Signalized Intersections
A.M. Peak Hour
Level of Service
Summary

0 200 400
Scale In Feet

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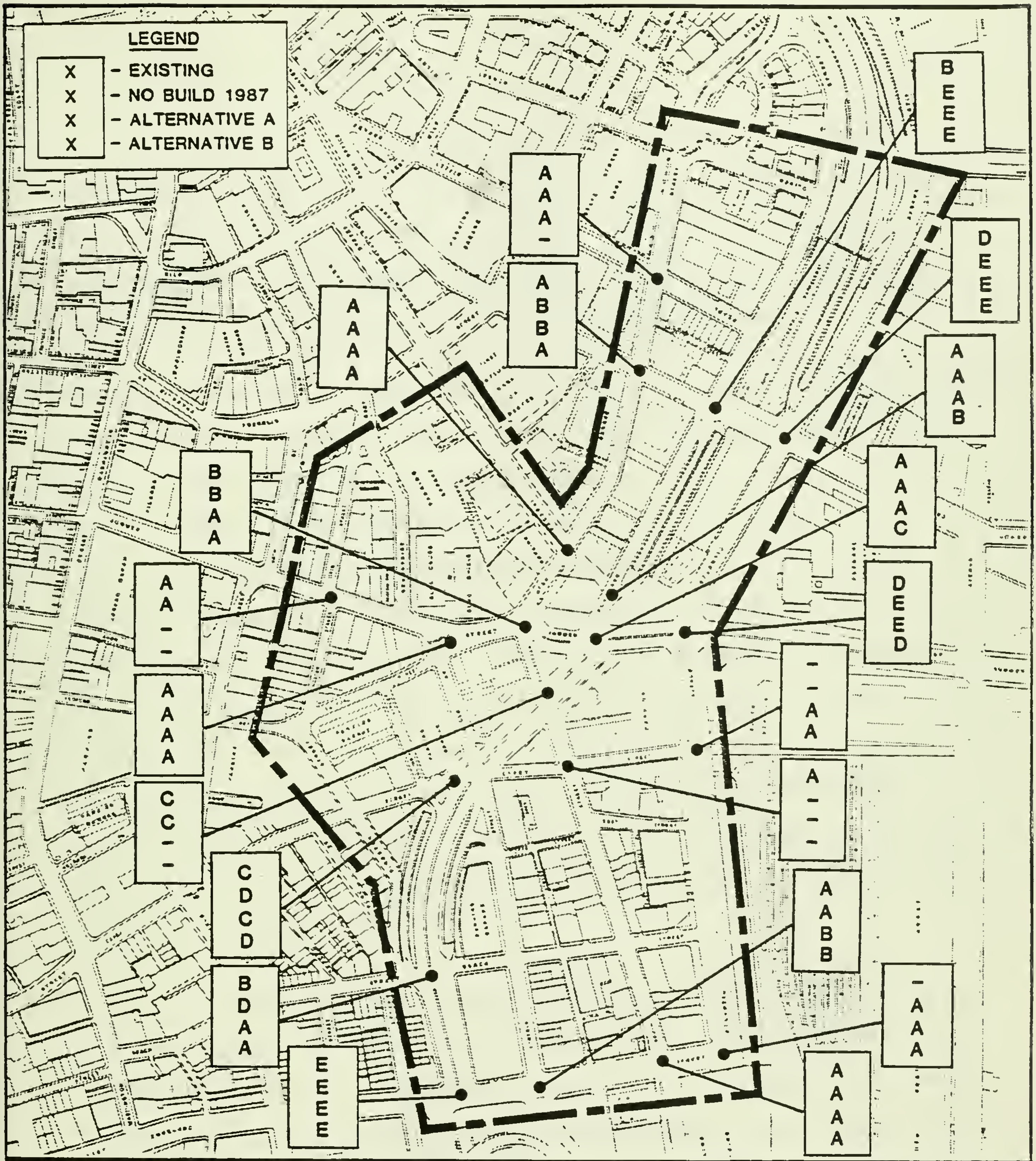
Authority



DEWEY SQUARE

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Figure 21
Signalized Intersections
P.M. Peak Hour
Level of Service
Summary

0 200 400
Scale in Feet

Boston
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Authority

The results of the analysis point to several key intersections which will control operations through the area. These key intersections could function as bottlenecks and affect other nearby intersections. As a result, the reader should not be misled by a high level of service (this issue is discussed later).

The Critical Movement Analysis indicates that the key bottlenecks identified in the study area include the following intersections:

-- Kneeland Street/Surface Artery;

-- Atlantic Avenue/Summer Street;

-- Congress Street/Atlantic Avenue; and

-- Congress Street/Purchase Street.

The first two intersections listed could be termed as current bottlenecks, particularly during the PM peak period and will continue to be under all future alternatives. The latter two are currently less of a problem although both are projected to worsen considerably as traffic demands increase in the area. It is important to note that the various roadway improvement options will have differing impacts on these intersections.

For example, the projected V/C ratio at the Surface Artery/Kneeland Street intersection will rise from 1.00 (Base) to 1.14 under the No Build conditions. While LOS "E" operations are still projected at this location, the V/C ratio under both Alternatives A and B is reduced to 1.03. This change is measurable and shows that the implementation of either project will serve to reduce the expected impacts of traffic growth. Kneeland Street operations would benefit as a result.

For comparison purposes, Table 14 was developed to present a summary of level of service by intersection. It shows the number of intersections in each level of service range, by alternative. Of particular interest is that by combining the AM and PM peak conditions, the analysis indicates five intersections at LOS D or E under base conditions. By 1987 under the No Build condition, nine intersections would be at LOS D or E. Alternatives A and B show 9 and 10 intersections at LOS D or E under those same conditions in 1987. It can be concluded, therefore, that the differences between the three 1987 alternatives are not that great in relation to the LOS analysis. It does show under Alternative B (in comparison with Alternative A), two more out of the 40 conditions studied would be at LOS "D" or "E".

The level of service analysis is informative in that it shows the relative impacts of the various alternatives on the street system. It provides a standard by which the alternatives can be compared. It does not, however, provide all of the information necessary to make project decisions. There are several drawbacks to the technique which limit its usefulness. First, it assumes optimal signal timing which is not always the case. Secondly, and probably more importantly, is the fact that the critical movement analysis does not recognize the interrelationships between intersections, particularly in the areas of signal coordination. As mentioned previously, this fact can lead to a somewhat optimistic analysis and is a point the reader should be aware of.

TABLE 14
CRITICAL MOVEMENT ANALYSIS
NUMBER OF INTERSECTIONS PER LEVEL OF SERVICE RANGE

Level of Service	Base		1987 No Build		1987 Alternative A		1987 Alternative B	
	AM	PM	AM	PM	AM	PM	AM	PM
A	6	10	8	9	10	10	8	8
B	8	3	4	2	1	2	3	2
C	2	2	3	1	1	1	0	1
D	2	2	2	2	2	0	1	1
E	0	1	1	4	3	4	4	4
Number of Intersections with LOS D or below	2	3	3	6	5	4	5	5

To address the issues of coordinated signal operations, a detailed analysis of traffic operations along the major corridors in the study area was conducted. This analysis of the two alternatives is included in the following section.

B. TRAFFIC SIGNALIZATION IMPROVEMENTS

As discussed in previous sections, traffic flow problems related to traffic signal operation are experienced in the Dewey Square area. Major reasons for these problems are limited intersection capacity, inadequate storage between intersections, heavy bus activity competing with automobile traffic, heavy pedestrian volumes and exclusive pedestrian phases which reduce the efficiency of signal operations.

The operation of all of the signalized locations in the study area were analyzed to determine potential improvements to signal timing, progression on major arteries and signal phasing. Also considered was the impact on queuing along the key arterials in the study area.

The capacity, signal phasing and timing of the signalized intersections in the Dewey Square area were analyzed for the No-Build, Alternative A and Alternative B conditions, based on the projected 1987 traffic volumes.

Based upon the proposed geometric and traffic operations improvements under Alternatives A and B, the progression on Surface

Artery, Kneeland Street and Atlantic Avenue was analyzed in detail and a progression concept was developed for these arterial streets for the AM and PM peak hours.

Phasing diagrams, preliminary AM and PM peak signal timings and capacity analyses were also prepared for the major intersections in the study area.

1. Existing Traffic Signalization

The existing traffic control system in the Dewey Square area provides fixed time operation at all intersections. Three groups of intersections within the study area are interconnected and coordinated with seven intersections coordinated as the existing Dewey Square system. The remainder of the intersections in the study area are incorporated in either the Surface Artery system or the Finance District system. With no common master, no coordination is currently provided across system boundaries.

A number of cycle lengths are utilized with 100 seconds being the maximum cycle length implemented. Cycle lengths, splits and offsets are varied on a time of day basis within the study area, meaning that signal timings are changed during the day on a regularly scheduled basis.

Pedestrian button actuated exclusive pedestrian phases are currently provided at many intersections in the Dewey Square area. When actuated, the time for this phase is generally taken from the

main road's green phase. This has the undesirable effect of reducing green time on a high volume roadway, and potentially disrupting a platoon of vehicles progressing down the street.

Signal progression is difficult to achieve on the existing two-way street system, particularly during off-peak balanced flow conditions where it is not appropriate to provide offsets for only one direction of travel. Green bands tend to be considerably narrower when progression is provided on an arterial in two directions simultaneously.

The existing system currently experiences major operational problems at the Purchase Street/Summer Street intersection and at the Surface Artery/Kneeland Street intersection. The problems are due in part to heavy traffic volumes, lack of adequate storage area, narrow lane widths, and changing traffic patterns. Signals designed using relatively old traffic data such as the Purchase Street/Summer Street intersection lead to problems when those volumes are significantly different today from when the initial data was collected. In this case, the left turn from Purchase Street to Summer Street is considerably higher today. Additionally, the lack of a bus priority scheme in the existing signalization allows for considerable friction between automobiles and buses within the study area.

2. Progession Improvement Goals

Traffic flow improvements related to the signalization of individual intersections are justified when they increase the capacity of the intersection, simplify intersection operations, or increase the safety of the intersection.

Improvements to intersections are also required when the roadway improvements described in Alternatives A and B change traffic flow patterns. For example, making Surface Artery a one-way street will require modifications to the existing traffic signal equipment to provide for one way operation.

The geometric and traffic flow improvements proposed for Alternatives A and B provide the opportunity to reanalyze the offset relationships between intersections on Surface Artery, Kneeland Street and Atlantic Avenue. The major roadway improvements related to the signalization concept proposed for both alternatives are:

- They create a series of one-way streets in the Leather District/ South Station area. Atlantic Avenue and Lincoln Street would carry only northbound traffic while South Street and Surface Artery would accommodate southbound traffic only.
- Essex Street would be widened and improved to carry two-way traffic.

As discussed previously, the major difference between Alternative A and Alternative B is that the direction of traffic flow on High Street is reversed from its current southbound direction under Alternative B. This causes only a small change in projected volumes between the two options at intersections other than those on High Street. Therefore, the requirements of the progression analysis are generally the same for both alternatives.

Making Surface Artery and Atlantic Avenue a one-way couplet requires that offset relationships be developed between intersections to allow the maximum number of vehicles to move southbound on Surface Artery from Dewey Square to Kneeland Street without stopping. Progression must be provided on Atlantic Avenue to allow vehicles to move northbound from Essex Street through the Dewey Square intersection. Making these two arteries one-way allows for better progression in both directions by allowing for a wider green band than could be provided by two-way progression.

An additional requirement of the progression analysis is that the offsets developed account for standing queues of vehicles at downstream intersections. The relative offset between two intersections must allow vehicle queues at the downstream intersection to begin moving before the platoon from the upstream intersection arrives.

As part of the improvements, bus prioritization allows buses to receive preferential signal phasing to pass through an intersection or a series of intersections without stopping.

In the inbound directions, the bus prioritization concept must allow buses to move while automobile traffic is stopped, from the westernmost lane on Atlantic Avenue adjacent to the Dewey Square Tower, through Dewey Square and Purchase Street to High Street. The proposed roadway improvements will aid the prioritization scheme by providing an exclusive bus lane. Additionally, automobile left turns will be prohibited from Atlantic Avenue to Summer Street.

Channelization improvements at Beach Street and Surface Artery will allow outbound buses to move to the head of the Surface Artery queue rather than turning onto Surface Artery from Beach Street during the side street phase. This allows buses to enter the Surface Artery progression band and have a higher probability of arriving at Kneeland Street during the Surface Artery green phase.

3. Progression Calculations

The analysis and traffic volumes indicated only small differences in the design requirements of the signal progression plans. As a result, the discussion on traffic signal progression applies equally to both Alternatives A and B. The signals to be addressed under either alternative are the same, the only difference being along High Street which would be reversed. The areas of critical concern are along the major arterials (Atlantic Avenue, Surface Artery and Kneeland Street) and it is those streets for which the analysis was conducted.

Traffic signal progression was analyzed for three groups of intersections, as illustrated in Table 15. The intersections on Surface Artery were analyzed to provide progression from Purchase Street and the Central Artery off-ramp to Kneeland Street. The coordinated phase for progression on Surface Artery at Dewey Square is the Purchase Street/Expressway Ramp phase. Offset relationships were determined so that vehicles on the Purchase Street approach coming from Dewey Square enter the Surface Artery progression green band at the start of the Purchase Street/Expressway Off-Ramp green and progress down Surface Artery without additional stops.

Coordination on Kneeland Street was analyzed to provide two-way progression in both the AM and PM peak periods. The intersection of Kneeland Street and Atlantic Avenue is coordinated as part of the Kneeland Street arterial during the PM peak period. During the AM peak period, the Kneeland Street and Atlantic Avenue intersection is coordinated with the intersections along Atlantic Avenue to provide progressive movement for the heavy traffic volumes exiting the Turnpike.

The first stage in analyzing coordination of the three arterials was to determine the signal phasing and timing of each intersection. A capacity analysis was performed for all major intersections in the study area to determine the appropriate signal timing. The minimum cycle length to allow for adequate capacity was selected for the PM peak period to be 100 seconds. In the AM peak, it was determined that an 80-second cycle length was

TABLE 15
SIGNAL COORDINATION DATA

Signal System Intersection	Coordinated Phase	Relative Offset1/ (seconds) AM Peak	PM Peak
Surface Artery			
Purchase St./Central Artery Southbound Off-Ramp	C	0	0
Surface Artery/Essex St./Lincoln St.	A	9	8
Surface Artery/Beach St.	A	25	19
Surface Artery/Kneeland St.	A	28	26
Kneeland Street			
Kneeland St./Surface Artery	B	0	0
Kneeland St./Ramp/Lincoln St.	A	5	3
Kneeland St./Utica St.	A	2	3
Kneeland St./Atlantic Ave.	B	-	15
Atlantic Avenue			
Atlantic Ave./Kneeland St.	A	27	-
Atlantic Ave./Essex St.	A	47	55
Dewey Square (Summer St./Atlantic Ave.)	B	52	61
Atlantic Ave./Congress St.	A	68	78

1/ All offsets are measured relative to the signal timing at Dewey Square (Summer and Atlantic).

appropriate, even though some approaches at the Dewey Square intersection will be over capacity. This cycle length was selected because a longer cycle length would allow a queue to form on the Expressway ramp which would exceed the storage capacity of the ramp. Phasing was analyzed to determine the most efficient combination of movements. Analysis forms detailing the signal timing and phasing for major intersections in the study area are included in the Appendix.

After signal timings were determined, the relative offsets between intersections were calculated. Particular attention was paid to the effect of vehicles queued at downstream intersections on progression. The relative offset was calculated using the following formula:

Relative Offset = Offset of upstream intersection +
(seconds) travel time - queue clearance time

The queue clearance time was determined by first estimating the traffic that would arrive and queue at the downstream intersection on the coordinated phase red. This was done by determining the volume of turning traffic from the upstream intersection side street phase which arrives at the downstream intersection during its side street phases. The maximum lane queue was then calculated using an 80 percent probability that the queue would not be exceeded during a signal cycle, and the signal timing probability curves. The queue clearance time was then calculated as the maximum queue multiplied by the one second per vehicle. This queue clearance time allows standing vehicles at the downstream intersection to begin moving

before the platoon of vehicles from the upstream intersection arrives (additional information on queuing is presented in a following section). The previous Table 15 summarizes the calculated offsets. The travel time between intersections was calculated assuming a 25 mph travel speed between intersections.

Time space diagrams were prepared for each arterial under both the AM and PM peak signal timings. These diagrams, which are included in the Appendix, provided for the graphical determination of a green band for each arterial at a 25 mph speed. The significance of the green band is that it illustrates how a vehicle may progress down the arterial if it is traveling at the 25 mph progression speed.

During the AM peak, it is possible to provide a 31-second green band on Surface Artery from Purchase Street to Kneeland Street. In the PM peak, a 26-second band width can be achieved. On Kneeland Street, it is possible to obtain two-way progression. The relative offsets favoring eastbound progression were utilized for both the AM and PM peaks. In the AM peak, a 19-second eastbound band width and a 28-second westbound band width were achieved while during the PM peak, a 25-second eastbound band width and a 30-second westbound band width were calculated for Kneeland Street. For Atlantic Street, an 18-second AM peak band width and a 35-second PM peak band width were calculated. These changes will allow for a more efficient operation on the area streets through the coordination of the three different signal systems and the resultant progression

flow improvements. The two designs have been developed to maximize available demands and respond to changing travel patterns during the AM and PM peak periods.

As mentioned previously, the analysis presented herein does not differ significantly between the two alternatives in relation to the major arterial streets. Only on High Street do the two plans differ significantly, primarily because of the reversal under Option B.

4. Bus Prioritization Plan

There are a number of ways to provide priority treatment for buses passing through the area including separate signal phases and bus lanes for the exclusive use of buses. Option 1 for the inbound express bus routes utilized these ideas by having an exclusive movement for buses while all other vehicular movements are stopped (except for the northbound through movement on Atlantic Avenue). The exclusive bus lane on the left side of Atlantic Avenue would allow buses to move to the head of the queue of automobiles and not be delayed by long queues of vehicles. Left turns by automobiles on Atlantic Avenue would be prohibited to further aid buses moving through the intersection. Similarily, an exclusive bus lane on Summer Street would separate buses from the main traffic stream and allow them to bypass automobile queues. Once through the Summer Street/Purchase Street intersection, buses would move with mixed traffic to the Federal and Franklin Street bus stops.

Because Option 2 for inbound routing is the preferred alternative, the implementation potential for providing preferential bus treatments appears limited to providing an exclusive bus lane along a portion of Atlantic Avenue. The issue of restricting AM peak hour parking on Atlantic Avenue must be addressed in order to be able to provide a separate bus lane. At the present time, it appears that parking will remain in front of the Hotel Essex however restricting it during peak AM periods would make an exclusive busway considerably more feasible.

Bus prioritization for exiting buses would be accomplished through the provision of an exclusive busway from Kingston Street and by giving buses preferential treatment at the Beach Street intersection. Once past this section, buses travel with mixed traffic for only one more block and are at the Southeast Expressway/ Turnpike ramp intersection.

Because of the relatively narrow streets which generally allow parking on one or both sides and the rather difficult geometry associated with the bus travel paths, it does not appear that further bus prioritization improvements through the area are feasible.

5. Intersection Signal Modifications/Improvements

Changing Surface Artery and Atlantic Avenue from two-way to one-way streets will require modifications in the placement of signal hardware to reflect one-way operation.

Phasing modifications and improvements will be possible at the following intersections:

- Surface Artery and Beach Street - Geometric changes to the intersection will allow for simple two-phase operation rather than the existing and confusing three-phase operation.
- Surface Artery and Kneeland Street - With a one-way Surface Artery, the signal phasing must be modified. The leading left-turn arrow for traffic turning from Kneeland Street eastbound to Surface Artery can be eliminated. An analysis of projected volumes indicates that the new phasing should be three phases with a lagging left-turn arrow for westbound traffic on Kneeland Street to enter the Turnpike on-ramp.
- If Alternative B is selected and High Street is reversed in direction, signalization may be eliminated at High Street and Federal Street and High Street and Pearl Street because conflicting movements have been eliminated. It will probably be desirable to install pedestrian push button signals at one or both of these locations to insure safe pedestrian crossings.

6. Analysis of Queue Lengths

An Analysis of the expected queue lengths under the future alternatives at the major intersections in the study area was performed. Due to the similarity in volumes between alternatives, Alternative B volumes were used. Alternative A queues will be essentially the same except along High and Purchase Streets. A separate discussion of these corridors under Alternative A is incorporated in the text.

A uniform distribution of arrivals was assumed at each intersection. This will illustrate the worst possible queuing situation because none of the benefits of coordination are considered in the analysis. Additionally, with considerable friction from double parked vehicles and pedestrians, platoons of vehicles will tend to break up, making the use of uniform arrivals appropriate for an analysis of queue lengths.

The queues forming at each intersection were determined using the preliminary signal timings and the following formula:

[(Approach Volume) - (Volume Arriving on Green)] +
(# of Cycles per Hour) = Vehicles Arriving on Red/Cycle

The signal timing probability curves were then used to adjust the calculated number to be the 80 percent probability of the number of vehicles arriving per cycle. This number was then adjusted, based on the number of lanes on the approach to be the number of vehicles stacked or queued per lane.

Figures 22 and 23 present the existing queues under base volume conditions[1/]. The following Figures 24 and 27 present the results of the analysis of future conditions under Alternatives A and B. It should be realized that the queuing analysis presents only one aspect of the operations in the study area and must be taken in context with the capacity and progression analysis. The results indicate the locations of considerable queuing to be on Lincoln Street, Purchase Street, Atlantic Avenue and Congress Street during the morning. The figure reveals generally very short queues on other area streets, primarily as a result of more efficient signal phasing. Careful inspection of the figure shows that the queuing on Atlantic Avenue for Summer Street has been developed so as not to extend beyond Essex Street. This will allow vehicles turning north from Essex Street to enter the Atlantic Avenue traffic stream. Queuing will continue along Purchase Street and on the southbound Central Artery off-ramp similar to today. Similarly, queuing on Kneeland Street may at times result in blockages of side streets at times as shown on the figure. This is caused by the closing of South Street to through traffic and the elimination of the northbound Surface Artery.

During the PM peak, queues will continue to be short on Surface Artery due to the elimination of conflicts at Kneeland Street, the provision of four travel lanes and the ability to provide more green time under either alternative. It appears that queuing on Atlantic

---

[1/] Calculated by SG Associates.

Fig 23

Existing
PM
Queues

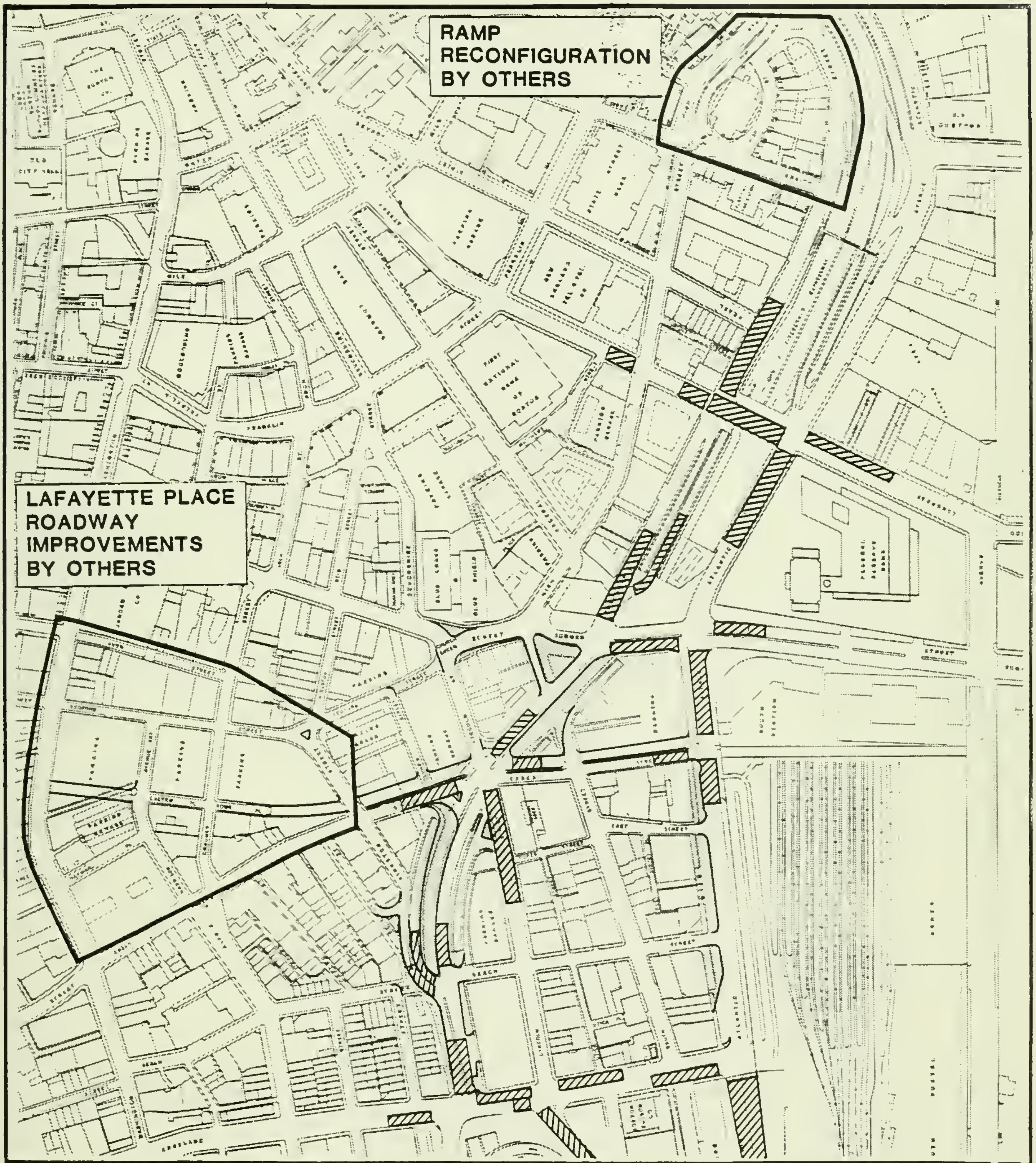

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Figure 24

Estimated Queue Lengths
At Major Intersections
Option A–AM Peak

0 200 400
Scale in Feet

Boston
Redevelopment
Authority

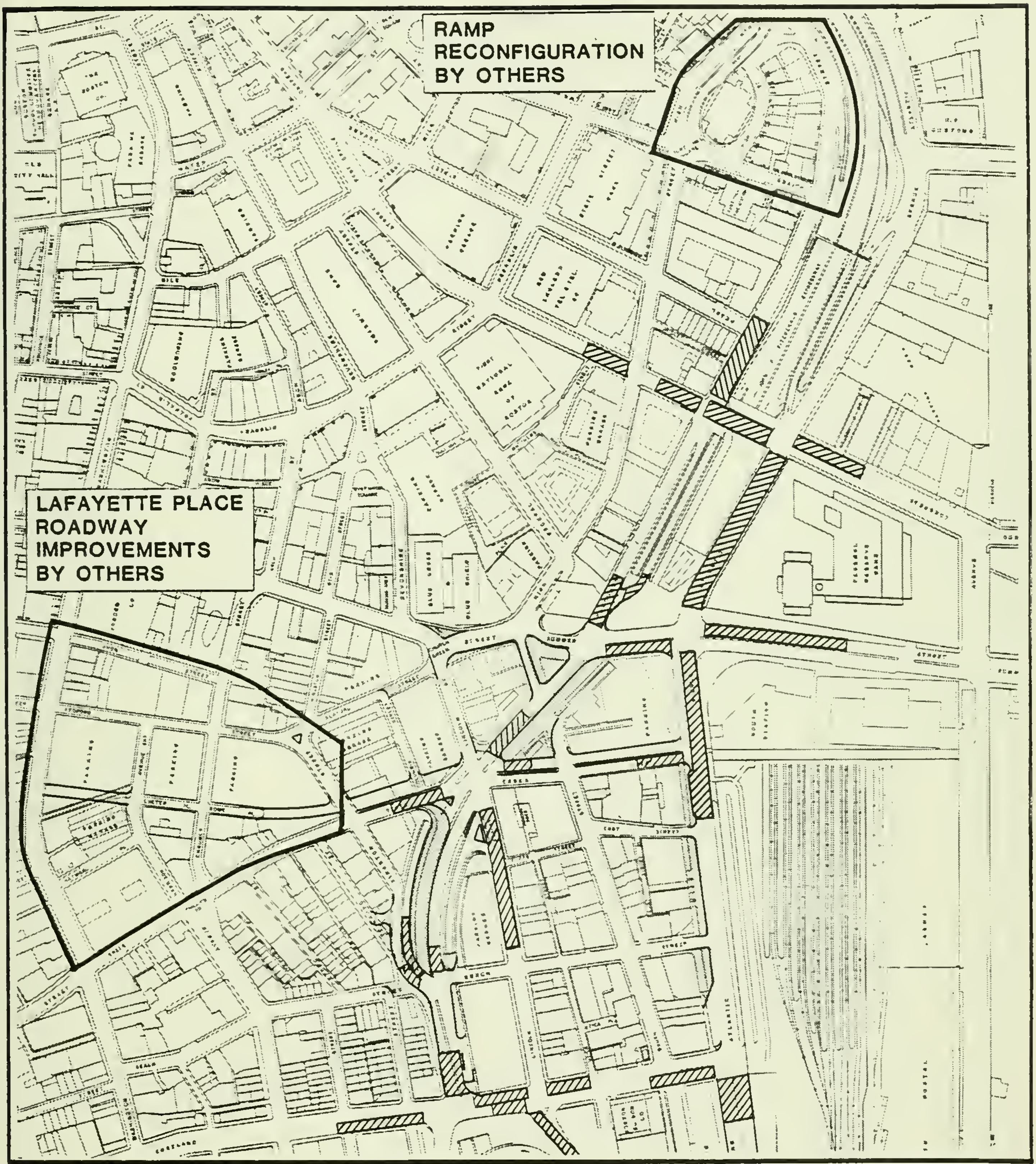
RAMP RECONFIGURATION BY OTHERS
LAFAYETTE PLACE ROADWAY IMPROVEMENTS BY OTHERS
0 200 400
Scale in Feet

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Figure 25

Estimated Queue Lengths At Major Intersections Option A-PM Peak

Boston Redevelopment Authority

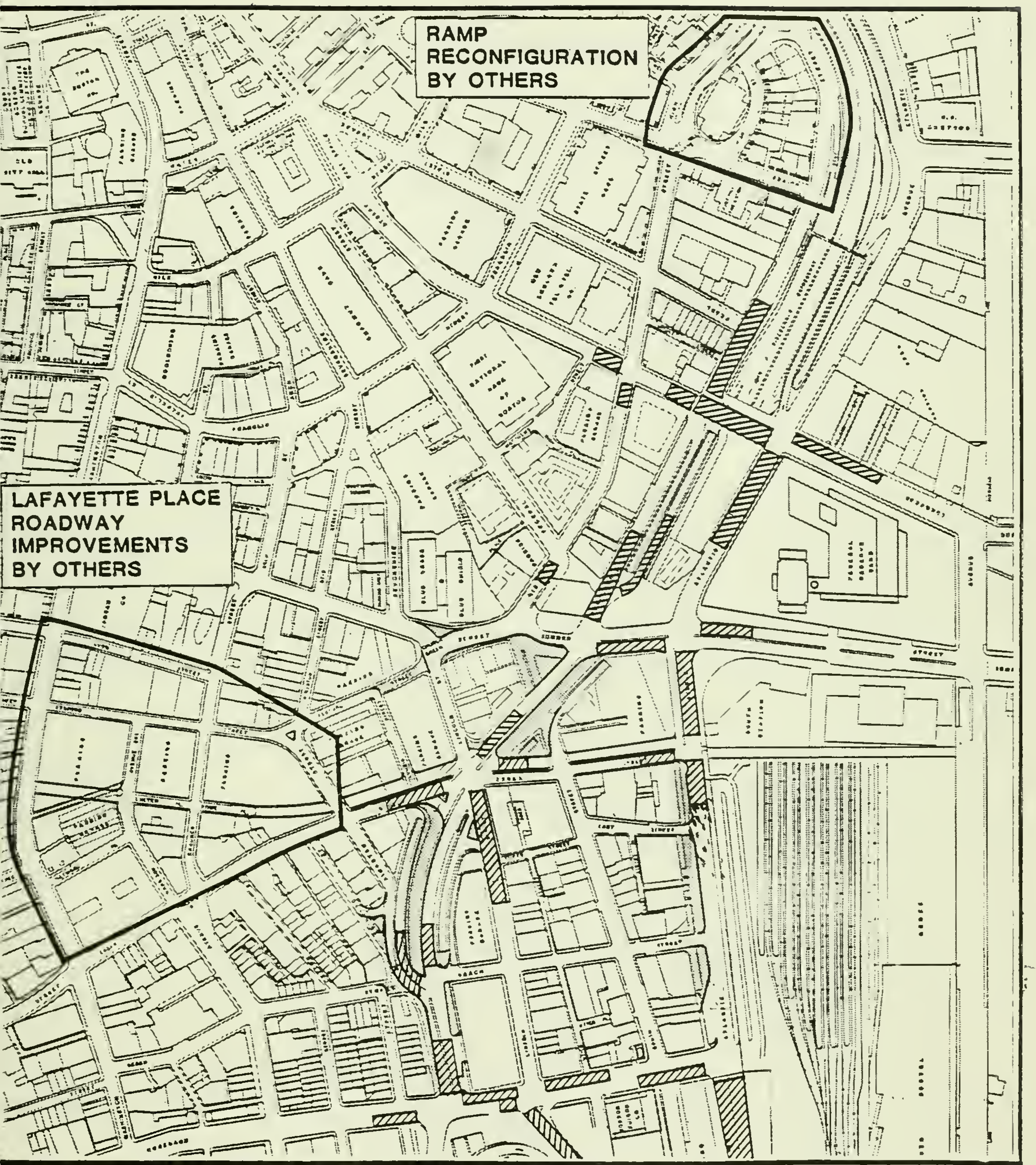
RAMP RECONFIGURATION BY OTHERS
LAFAYETTE PLACE ROADWAY IMPROVEMENTS BY OTHERS

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Figure 26

Estimated Queue Lengths
At Major Intersections
Option B–AM Peak

0 200 400
Scale in Feet

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Redevelopment
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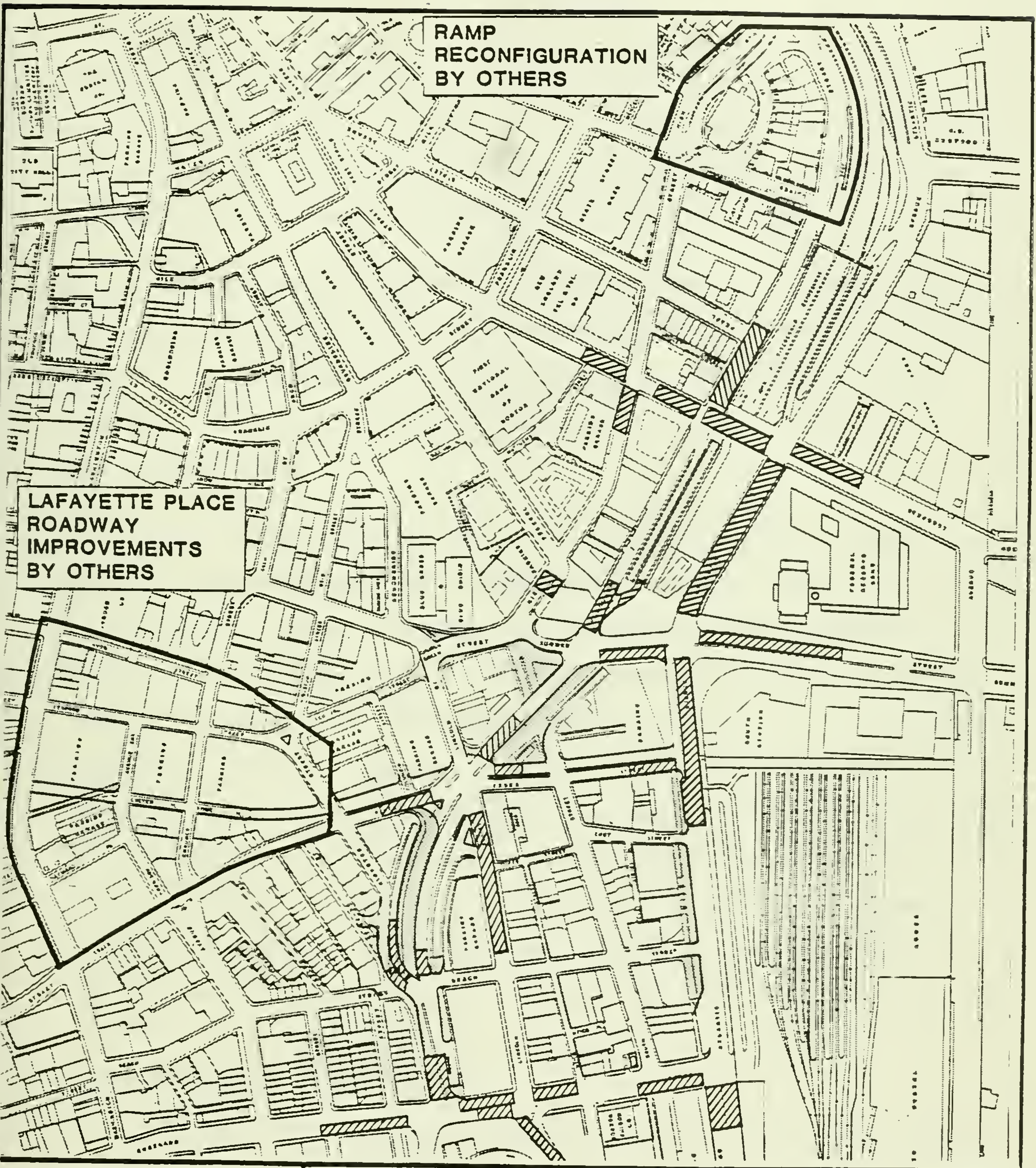
RAMP RECONFIGURATION BY OTHERS
LAFAYETTE PLACE ROADWAY IMPROVEMENTS BY OTHERS
0 200 400
Scale in Feet

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Figure 27

Estimated Queue Lengths At Major Intersections Option B–PM Peak

Boston Redevelopment Authority

Avenue will continue to be problematic south of Congress Street. Because the potential solutions at this location are quite limited and because of traffic growth due to areawide developments, this condition will worsen in comparison to todays volumes.

The differences between the two Alternatives are small and are primarily evidenced in the High Street corridor. Generally on High Street, the queuing simply occurs on the northbound side of the various signalized intersection rather than on the current southbound side.

Queue lengths are reduced considerably within this study area over the queue lengths for the existing condition estimated in previous studies. Severe congestion is currently experienced on Surface Artery during the PM peak condition for southbound traffic and implementation of either Alternatives A or B will reduce congestion considerably. Queue lengths on Surface Artery at the Surface Artery/Kneeland Street intersection, as estimated for Alternative B will not block traffic at the Surface Artery/Beach Street intersection. Queue lengths at Dewey Square, particularly on Summer Street eastbound and Atlantic Avenue northbound will also be significantly reduced.

7. Impacts on Mobility

The implementation of Alternatives A or B will have a number of desirable effects:

- The creation of the Surface Artery/Atlantic Avenue one-way couplet will improve traffic operations by increasing capacity and eliminating conflicts between left turning vehicles and opposing traffic.

  The plans eliminate many of the shorter blocks which are one of the current causes of congestion. It also removes larger vehicles and buses from these shorter blocks, improving flow conditions for all vehicles.

- Exclusive pedestrian intervals can be eliminated due to the implementation of one-way streets particularly on Surface Artery, improving traffic flow while still providing a safe pedestrian environment. Pedestrian improvements will also be created in the Church Green area due to the reduction in conflicts and the planned signal phasing. Fewer movements to cross and simplified signal phasing will increase pedestrian time and improve flow. Pedestrian safety will also be greatly improved since it would be possible to provide longer crossing times with the one-way patterns. Further, the width reduction on Surface Artery will shorten pedestrian crossing distances. Similarly, by simplifying the signal phasing at Summer Street/Atlantic Avenue, pedestrian crossings will be improved over the current multi-phase plan with the concurrent pedestrian crossings.

- Signal progression can be improved on all of the one-way streets, particularly Atlantic Avenue and Surface Artery.

The benefits of progression are much easier to attain and it will be considerably easier to implement on a one-way system to reduce the potential for "gridlock." With the new progression system on Surface Artery, it would be considerably easier to leave the area.

- Priority treatment can be provided along portions of bus routes in the study area, therefore, automobile/bus conflicts will be reduced by separating the two modes. This is particularly true for outbound buses destined for the Turnpike.

- Congestion, as with standing queues of vehicles blocking intersections, will be reduced.

Option B will reverse the direction of flow on High Street, and have the desirable effect of eliminating the need for traffic signal control at two intersections. This change is particularly compatible with the short term plans to relocate the High Street off-ramp to Purchase Street as part of the planned International Place project. It is also compatible with the long range plans for depressing the Central Artery. This change will result in a greater dependence on Purchase Street to accommodate southbound traffic.

The two options do provide considerable benefits for access into the Leather District. Access to and circulation within the area will be improved by the reversal of Beach Street (east end). This change is proposed to accommodate traffic exiting from the Beach Street Artery off-ramp. As a result, it will provide greatly

improved access to the South Station project from the north and may divert some traffic from the preceding Purchase Street exit ramp. The roadway configuration that remains would lend itself best to having South Street southbound to provide better opportunities for internal circulation in the area.

The project has many benefits, including the elimination of two traffic signals under Option B. It must be realized that implementation of either alternative will not totally solve all of the area's traffic problems. Congestion and capacity operations will continue to exist, with or without the project. The Summer Street/Atlantic Avenue intersection will continue to be congested, however operations on other area streets will experience improvements. Even at Dewey Square, by eliminating left turns to Atlantic Avenue, more time can be provided to the Atlantic Avenue traffic stream.

8. Project Impact on Dangerous Materials

With the implementation of Alternative A (which retains High Street as a one-way southbound roadway) or the No Build conditions, there would be no real change in the flow of hazardous or dangerous materials. Only with the implementation of Alternative B would the flow of these materials be affected.

The initial plan developed for Alternative B would have required southbound Central Artery vehicles carrying dangerous materials to use the High Street exit, follow Oliver Street past the Boston Fire Station to Purchase Street where a right turn would

be required. Trucks would then proceed south on Purchase Street to Surface Artery where connections to the Southeast Expressway could be made. While the turn from Oliver to Purchase Street would be physically possible, it would be fairly difficult for the very largest trucks, particularly with the parking on Oliver Street and the traffic conflicts on Purchase Street. There was considerable concern about this turn expressed by representatives of the City's Fire Department. It was their feeling that this would result in an unsafe condition and could lead to an accident that might cause a spill of flammable materials (oil, gasoline) into the Dewey Square depressed section of the Central Artery. One partial solution that was identified involved the relocation of the existing pedestrian bridge. By shifting the touchdown point from the east side of Purchase Street to the west side adjacent to the Travelers Building, it would be possible to improve the turning radii at the Oliver Street intersection. This would provide more room for trucks to turn the corner and make the turn somewhat easier. While this change would improve the turn, it would not eliminate the need for it to be made.

Because of the planned relocation of the High Street off-ramp as part of the International Place project, the problems with trucks carrying dangerous cargos would essentially be eliminated. All trucks would exit from the Central Artery via the relocated off-ramp and then proceed south on Purchase Street to the Surface Artery. It would not be necessary for truck drivers to make the more difficult turn from Oliver Street to Purchase Street under

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Vanesse/Hagan Assoc.

AUTHOR

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